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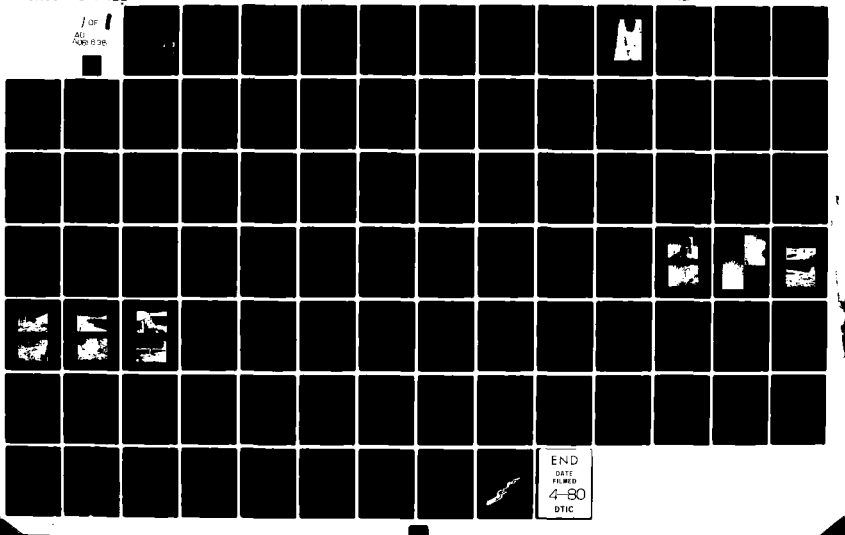

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DELAWARE RIVER BASIN
SHAWNEE CREEK, MONROE COUNTY

PENNSYLVANIA

SHAWNEE DAM

NDI ID NO. PA-00629
DER ID NO. 45-115

SHAWNEE DEVELOPMENT, INC.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ORIGINAL CONTAINS COLOR PLATES: ALL DDC
REPRODUCTIONS WILL BE IN BLACK AND WHITE

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JANUARY 1980

DELAWARE RIVER BASIN,

SHAWNEE CREEK, MONROE COUNTY,

PENNSYLVANIA, Phase I Inspection Report.

(6) National Dam Inspection Program.

SHAWNEE DAM

NDI-ID No. PA-00629
DER-ID Number 45-115

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PHASE I INSPECTION REPORT

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For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) JANUARY 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

DELAWARE RIVER BASIN

SHAWNEE CREEK, MONROE COUNTY

PENNSYLVANIA

SHAWNEE DAM

NDI ID No. PA-00629
DER ID No. 45-115

SHAWNEE DEVELOPMENT, INC.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JANUARY 1980

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APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Shawnee Dam NDI ID No. PA-00629 DER ID No. 45-115
Size:	Small (22 feet high; 132 acre-ft)
Hazard Classification:	High
Owner:	Shawnee Development, Inc. Charles Kirkwood, President P.O. Box 93 Shawnee on Delaware, Pa. 18356
State Located:	Pennsylvania
County Located:	Monroe
Stream:	Shawnee Creek
Date of Inspection:	13 November 1979

Based on visual inspection, available records, calculations, past operational performance, and according to criteria established for these studies, Shawnee Dam is judged to be unsafe, non-emergency, because the spillway capacity is rated as seriously inadequate. The existing spillway will pass only about 38 percent of the Probable Maximum Flood (PMF) without overtopping of the dam. If the low area on the top of the dam were filled to the design elevation, the spillway would pass only about 41 percent of the PMF, and it would still be rated as seriously inadequate. For either condition, it is judged that the dam could not withstand the depth and duration of overtopping that would occur for the 1/2 PMF. Failure of the dam would cause an increased hazard for loss of life downstream. As a whole, the dam is judged to be in poor condition. → next page

No stability problems were evident for the embankment at the time of the visual inspection, but a potential hazard exists due to significant seepage at and near the toe of the dam.

The spillway weir meets recommended guidelines for stability under the normal operating condition, but not under the assumed maximum loading condition. Under the assumed maximum loading, the ability of the weir to resist failure by sliding is questionable. Erosion of material that has occurred at the toe of the weir adversely affects the stability of the structure.

The ability of the outlet works to function is unknown.

Maintenance of the dam and appurtenant structures is inadequate.

The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, immediately:

(1) Remove flashboards, flashboard pins, fish screens, and fish screen supports from the spillway.

(2) Perform investigations and studies as required to assess the cause and hazard potential of the seepage areas. Take appropriate action as required.

(3) Perform additional studies to more accurately ascertain the spillway capacity required for Shawnee Dam as well as the nature and extent of measures required to provide adequate spillway capacity. The study should also address the deficiencies of the spillway apron and outlet channel. Take appropriate action as required.

(4) Perform additional investigations and studies to more accurately ascertain the structural stability of the spillway weir as well as the nature and extent of measures required to provide adequate factors of safety for structural stability under all loading conditions. Take appropriate action as required.

(5) Ensure the operational adequacy of the outlet works.

(6) Remove trees and brush from the embankment. Upon removal of brush and trees, the embankment should be inspected for bulges, cracks, and other signs of distress. Take appropriate action as required.

(7) Fill low area at top of dam, repair eroded area at top of dam, fill burrowing animal hole, and make repairs to spillway bridge.

All investigations, studies, designs, and supervision of construction should be performed by a professional engineer experienced in the design and construction of dams. Tree removal should be performed under the guidance of a professional engineer.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Shawnee Dam.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of Shawnee Dam.

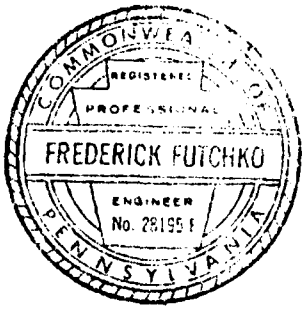
(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(4) Institute an inspection program such that the dam is inspected frequently. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(5) Institute a maintenance program so that all features of the dam are properly maintained.

SHAWNEE DAM

Submitted by:



GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 11 February 1980

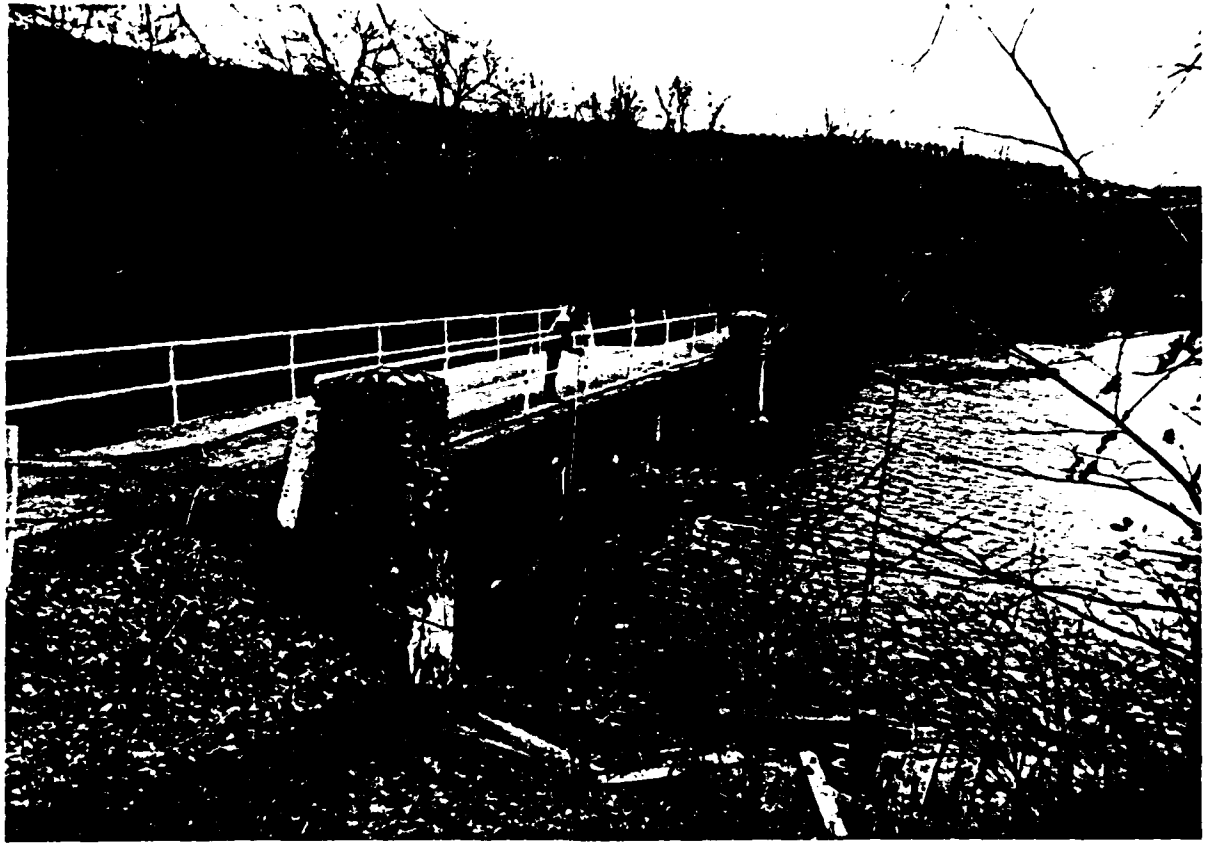
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 29 Feb 1980

SHAWNEE DAM



Overview

DELAWARE RIVER BASIN

SHAWNEE CREEK, MONROE COUNTY

PENNSYLVANIA

SHAWNEE DAM

NDI ID No. PA-00629
DER ID No. 45-115

SHAWNEE DEVELOPMENT, INC.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JANUARY 1980

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Shawnee Dam is an earthfill embankment 22 feet high at its maximum section and 385 feet long, including the spillway. A concrete

corewall, varying from 12 inches wide at its top to 18 inches wide at its base, is located at the center of the embankment. The corewall is founded on clay. The top of the dam is paved and serves as an access road.

The spillway is located near the left abutment, and it is a concrete weir with a rounded crest. The total length is 65 feet, but the effective crest length is reduced to 61 feet by 2 piers located atop the structure. A bridge crosses the spillway.

The outlet works is located about 60 feet right of the spillway at the maximum embankment section. A rectangular intake structure is located at the upstream toe of the dam, and its top extends to the elevation of the top of the dam. A sluice gate and a gate operating mechanism are located at the intake structure. The outlet works conduit is a 30-inch diameter, reinforced concrete pipe encased in reinforced concrete for its entire length. The encased conduit projects from the downstream toe of the dam. The various features of the dam are shown on the Photographs in Appendix C and on the Plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Shawnee Dam is located on Shawnee Creek in Smithfield Township, Monroe County, Pennsylvania, approximately 1 mile north of Shawnee on Delaware. Shawnee Dam is shown on USGS Quadrangle, Bushkill, Pennsylvania - New Jersey, at latitude N 41° 01' 30" and longitude W 75° 06' 05". A location map is shown on Plate E-1.

c. Size Classification. Small (22 feet high, 132 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Shawnee Dam (Paragraphs 3.1e and 5.1c (5)).

e. Ownership. Shawnee Development, Inc., Charles Kirkwood, President, P.O. Box 93, Shawnee on Delaware, Pennsylvania 18356.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The original design was performed by U. L. Gernet, Civil Engineer, of Nazareth, Pa., in 1925 for the Brookside Recreation Club.

The design was revised several times by E. H. Uhler, Civil Engineer, of Bethlehem, Pa. Final approval of the revised plans and specifications was granted by the Water and Power Resources Board in September 1926. The approved plan is shown on Plate E-2. Construction was started that same month under the supervision of E. H. Uhler. The Contractor was H. H. Heller of Stroudsburg, Pa. Construction was complete by June 1927. In July 1927, an inspection by Commonwealth representatives found that the dam had not been completed in accordance with the approved plans. It was found that the embankment was higher than shown on the plans, that the topwidth was 2 to 5 feet wider than design, that the upstream slope from normal pool level to top of dam was 1V on 1H, and that the downstream slope varied from 1V on 1.5H to 1V on 1.75H, instead of being 1V on 2H as shown on the plans. The Commonwealth directed the Owner to prepare as-built drawings and to flatten the downstream slope to 1V on 2H.

In 1929, another inspection by the Commonwealth found that modification of the downstream slope had not been performed, and also that the Owner had installed flashboards. The Owner was directed to immediately remove the flashboards and to flatten the downstream slope. In January 1930, E. H. Uhler prepared plans to modify the dam and spillway. The proposed modifications included raising the spillway bridge, installing flashboards, and flattening the downstream slope to 1V on 2H. Revised plans for those changes were approved in May 1930 (Plate E-3). The bridge was raised and the flashboards were installed in 1931, but the modification of the downstream slope was not performed. Between 1930 and 1949, the Owner was repeatedly directed to complete the downstream slope in accordance with the approved plans. The Owner was directed to remove the flashboards and to not replace them until the work was completed. Other than minor maintenance, there was apparently no other work performed on the dam or structures to the present time.

h. Normal Operational Procedure. The pool is maintained at the spillway crest level with excess inflow discharging over the spillway. The outlet works is not used. Spillway discharge flows downstream to the confluence with the Delaware River.

1.3 Pertinent Data.

a.	Drainage Area. (square miles)	3.8
b.	Discharge at Damsite. (cfs.)	
	Maximum known flood at damsite	Unknown.
	Outlet works at maximum pool elevation	118
	Spillway capacity at maximum pool elevation	
	Design conditions	3,050
	Existing conditions	2,810
c.	Elevation. (Feet above msl.)	
	Top of dam	
	Design conditions	439.4
	Existing conditions	439.1
	Maximum pool	
	Design conditions	439.4
	Existing conditions	439.1
	Normal pool (spillway crest)	433.9
	Upstream invert outlet works	418.5
	Downstream invert outlet works	417.8
	Streambed at toe of dam	417.4
d.	Reservoir Length. (miles)	
	Normal pool	0.32
	Maximum pool	0.42
e.	Storage. (acre-feet)	
	Normal pool	61
	Maximum pool	132
f.	Reservoir Surface. (acres)	
	Normal pool	12
	Maximum pool	15
g.	Dam.	
	Type	Earthfill with concrete corewall.
	Length (feet)	385
	Height (feet)	22

g.	Dam. (Cont'd.)	
	Topwidth (feet)	10.5 (average)
	Sides Slopes	
	Design	
	Upstream	1V on 2H
	Downstream	1V on 2H
	Existing Conditions	
	Upstream	1V on 2H (Record data)
	Downstream	1V on 1.75H (Average-measured)
	Zoning	None.
	Cut-off	Corewall founded on clay.
	Grout Curtain	None.
h.	Diversion and Regulating Tunnel.	None.
i.	Spillway.	
	Type	Concrete weir.
	Length of Weir (feet)	61.0
	Crest Elevation	433.9
	Upstream Channel	Reservoir, vertical concrete walls.
	Downstream Channel	Grouted stone apron.
j.	Regulating Outlets.	
	Type.	One 30-inch diameter reinforced concrete pipe.

j. Regulating Outlets. (Cont'd.)

Length (feet)	98
Closure	Slide gate at intake structure at upstream end.
Access	By boat.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Design data available for review included the following: approved design drawings for original structures and subsequent modifications; specifications for original construction; foundation data from test pits; permit application reports for original structures and modifications; and computations for spillway and flashboard analyses.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the Photographs in Appendix C and on Plates E-2 and E-3 in Appendix E. The embankment is shown on Photographs A through D. The spillway is shown on Photographs E through H. The outlet works is shown on Photographs I and J.

c. Design Considerations. Hydraulic and structural design considerations for the spillway weir are covered in Sections 5 and 6, respectively. For the dam, nothing was noted in the review of the design data that would cause concern. The specifications were detailed and generally reflected good engineering practice.

2.2 Construction.

a. Data Available. Construction data available for review included construction progress reports prepared by the Commonwealth, as-built drawings, and correspondence regarding construction.

b. Construction Considerations. The Commonwealth inspected the foundations for the corewall and for the spillway weir. Requests by the inspectors for changes in grade and methods of construction to provide better foundation conditions were reportedly adhered to. A final inspection of the project by the Commonwealth revealed departures from approved lines and grades, as described in Paragraph 1.2g.

2.3 Operation. There are no formal records of operation. The present Owner only recently acquired the dam. A record of operation does exist in the form of inspection reports prepared by the Commonwealth between 1927 and 1969. The findings of the previous inspections are discussed in other applicable section of this Report.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). The Owner made available his Grounds Superintendent for information during the visual inspection. He also researched his files for information at the request of the inspection team.

b. Adequacy. The type and amount of available design data and other engineering data are limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam is poor. Deficiencies were observed as noted below. A sketch of the dam with the locations of deficiencies is presented on Exhibit B-1 in Appendix B. Survey information acquired for this report is summarized in Appendix B. On the day of the inspection, the pool was 0.1 foot above spillway crest.

b. Embankment. The top of the dam is paved and used as an access road (Photograph A). The measured average topwidth is 10.5 feet. A low area, 0.3 foot below design level for top of dam, is located at the right abutment. All other portions of the embankment are at or above the design elevation. One area was observed on the top of the dam that has undergone erosion (Photograph B). It is on the downstream side of the dam adjacent to the left abutment of the spillway.

Most of the upstream slope of the embankment was submerged and could not be inspected. The portion of the slope above normal pool level is overgrown with brush and trees (Photograph C). The riprap is intact, but it does not extend to the top of the dam. The portion of the slope above the pool level is steep. At the surveyed section, the riprap is on a slope that measured about 2V on 1H, and the embankment above the riprap has a slope of about 1V on 2H.

The downstream slope of the embankment is overgrown with brush and trees (Photograph D). Tree sizes range from saplings to 18-inch diameter, and at least one large tree is dead. At the surveyed section, the downstream slope is about 1V on 1.75H. One burrowing animal hole was observed on the downstream slope. Seepage was observed at four locations along or near the toe of the dam. Near the right abutment were two seepage areas that had clear flow of about 1 gallon per minute (gpm) each. At the end of the outlet conduit, a concentrated, clear flow

estimated at 30-50 gpm was observed (Photograph D). Between the outlet conduit and the spillway, a clear flow of about 3 gpm was observed. Although the discharge was small, it was concentrated and flowed with considerable force. In addition to the seepage, there was also flow along or near the toe caused by water escaping from the spillway outlet channel. The locations of seepage areas and wet areas are shown on Exhibit B-1.

c. Appurtenant Structures. The spillway approach channel was obstructed by a fish screen and by the supports for the fish screen (Photograph E). Some floating debris was present. Flashboard pins were in place in all three bays of the spillway. A 6-inch high flashboard was in place in the right bay, and a partially displaced flashboard was in the left bay (Photographs E and F). The concrete of the spillway structures is in fair condition, with local areas of cracking and disintegration at the ends of the piers and sidewalls (Photographs F and G). The concrete weir is in good condition. The wood decking of the spillway bridge is rotted at various locations. The underside of the spillway bridge was determined to be at Elevation 439.2, which is 0.1 foot above the existing top of the dam and 0.2 foot below the design top of the dam. Only remnants of the grouted stone apron are visible (Photographs G and H). Erosion at the toe of the spillway weir is severe (Photographs F and G). The apron, which was once grouted, consists now of mostly large, loose rock. A cutoff wall located at the downstream end of the apron is badly undermined.

The outlet works intake structure and operating equipment could not be inspected, because access by boat is required (Photograph I). The Owner's representative stated that no crank was available for the gate operating mechanism, and that it is not known whether the outlet works is functional. The downstream end of the 30-inch diameter outlet conduit is visible at the toe of the dam (Photograph J). There was a slight flow through the conduit. About 30-50 gpm of seepage, described previously, discharged from the toe of the dam adjacent to the conduit (Photograph J.)

d. Reservoir Area. The watershed area is about 60 percent wooded and about 40 percent grassland. Only a minor amount of development is present. The terrain varies from steep, mountainous areas to nearly flat areas in the valley. Camp Sun Mountain Lake Dam, a 9-foot high dam, is located within the watershed about 0.45 mile upstream from Shawnee Dam. (Photographs K and L). Data for Camp Sun Mountain Lake Dam obtained during the visual inspection are included in Appendix B.

e. Downstream Channel. The valley downstream from Shawnee Dam is relatively narrow and steep. The confluence of Shawnee Creek with the Delaware River is about 1.5 miles downstream. The community of Shawnee on Delaware is located about 1.0 mile downstream from the dam. It was estimated that between 10 and 15 dwellings would be flooded if a failure of Shawnee Dam were to occur.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at the spillway crest level with excess inflow discharging over the spillway and into the downstream channel. The flashboards, in their existing condition, serve no useful purpose. The outlet works is not used. The fish screens are normally in place.

4.2 Maintenance of Dam. The dam is not maintained.

4.3 Maintenance of Operating Facilities. The outlet works is not maintained. The fish screens are cleaned as needed.

4.4 Warning Systems in Effect. The Grounds Superintendent stated that he was not aware of any emergency operation and warning system.

4.5 Evaluation of Operational Adequacy. The maintenance of the embankment, spillway, and outlet works is inadequate. Inspections are necessary to detect hazardous conditions at the dam. An emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. The available data for the spillway indicates that the design discharge coefficient for the weir is 3.88, and that both the top of the dam and the underside of the spillway bridge were to be constructed at Elevation 439.4, thus providing a maximum spillway design head of 5.5 feet. The spillway capacity used in this Report is 2,807 cubic feet per second (cfs), and it was computed using the design discharge coefficient and the maximum available head of 5.2 feet for existing conditions.

b. Experience Data. No records of maximum pool levels were available.

c. Visual Observations.

(1) General. The visual inspection of Shawnee Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics. These observations are evaluated herein for the various features.

(2) Embankment. The low area on the top of the dam limits the existing spillway capacity to less than the design capacity.

(3) Appurtenant Structures. The fish screens and fish screen supports are serious obstructions that could catch debris and significantly reduce spillway capacity. The flashboards serve no useful purpose, and they obstruct the spillway. The underside of the spillway bridge was found to be lower than the design elevation, which might cause pressure flow. Discharges under pressure flow would be less than under a free overfall condition. In computing the existing spillway capacity and in evaluating the spillway adequacy, none of the effects of the above deficiencies were included. The spillway capacity computed and used in this Report assumes that all flashboards, fish screens, and fish screen supports were removed.

The ability of the outlet works to function is uncertain. Until additional investigations are made, it must be assumed that there is no means of drawing down the reservoir.

(4) Reservoir Area. Camp Sun Mountain Lake Dam, located 0.45 mile upstream, does affect the hydrology of Shawnee Dam. Its effects have been included in the hydrologic analysis. The records have shown the computed drainage area for Shawnee Dam at various times to be 3.1 and 3.9 square miles. The drainage area computed and used for this study is 3.8 square miles, 3.3 of which drain to Camp Sun Mountain Lake Dam.

(5) Downstream Conditions. No conditions were observed downstream from the dam that would reduce the hydraulic capacity of the spillway. Failure of Shawnee Dam would probably flood between 10 and 15 dwellings located along Shawnee Creek. The downstream conditions indicate that a high hazard classification is warranted for Shawnee Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (Small) and hazard potential (High) of Shawnee Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Because of the downstream conditions, the PMF is selected as the SDF for Shawnee Dam. The watershed was modeled with the HEC-1DB computer program. A description of the model is included in Appendix D. The assessment of the dam is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Shawnee Dam can pass about 38 percent of the PMF before overtopping of the dam occurs. The dam is rated at its existing top elevation, with no reduction in capacity for fish screens or flashboards. At its design top elevation, the dam can pass about 41 percent of the PMF. As part of this study, it was also found that Camp Sun Mountain Lake Dam, located upstream from Shawnee Dam, will pass less than 1 percent of the PMF before it is overtopped.

(3) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix D. Because an occurrence of the 1/2 PMF would result in overtopping of the dam, a failure analysis was performed. It was assumed that Shawnee Dam would begin to fail during the 1/2 PMF when the pool level reached Elevation 439.4, which is 0.3 foot above the low point on the top of the dam. Other assumptions used to model the failure are described in Appendix D. The resulting outflow was routed through stream sections downstream to dwellings located along Shawnee Creek. It was found that failure of Shawnee Dam would raise water levels at the dwellings by 3.2 feet to 4.8 feet over the levels that existed just prior to failure of the dam. There is an increased hazard for loss of life. Therefore, the spillway capacity is rated as seriously inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Shawnee Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Embankment. The eroded area on the downstream side of the top of the dam was not a serious hazard at the time of the inspection, but continued erosion is likely. As shown on the surveyed section in Appendix B, a portion of the upstream slope above the normal pool level is very steep (2V on 1H). Although it could not be verified by survey, records indicate that the submerged portion of the slope was constructed to the approved design slope of 1V on 2H. Provided that the record data are accurate, the small section of steep slope would not cause serious hazard to the safety of the embankment. Any failure that might occur would probably be a shallow slough that would not extend across the top of the dam. No evidence of sloughing or cracking along the upstream slope was apparent during the visual inspection. Although riprap does not extend to the top of the dam, there were no areas of wave erosion. Vegetation above the riprap has apparently provided adequate slope protection.

The growth of trees and brush on the upstream and downstream slopes is a hazard to the dam. Root systems can loosen embankment material, displace slope protection, and create paths along which seepage and internal erosion might occur. The large size of some of the trees that were observed, and the fact that at least one large tree near the toe was dead, increases the hazard potential. The burrowing animal hole observed on the downstream slope is of minor concern.

The two seepage areas and the swampy area located along the toe of the dam near the right abutment appear to be similar in character and extent to conditions described in previous inspections since about 1929. In

1934, E. H. Uhler, the engineer who supervised construction, is reported to have said that a spring was located in that area. Because of the similarity with previously described conditions, and because of the small quantity, the seepage and swampy area near the right abutment do not appear to be of a serious nature at the present time. Although the seepage area located downstream from the toe between the spillway and the outlet conduit might also have existed for a long time, it is of concern. The flow was clear and was only about 3 gpm, but the seepage was concentrated and flowed with considerable force. A potential for internal erosion, or piping, exists. Similarly, the large flow from the toe adjacent to the outlet conduit (30-50 gpm) is judged to be potentially hazardous. This seepage appears to have started about 1935. In 1969, after an inspection by the Commonwealth, the Owner was directed to investigate the condition and make repairs. The seepage, estimated at about 50 gpm in 1969, was judged by the Commonwealth to be a hazard to the dam. The Owner in 1969, M. J. Escoll, replied that the condition was virtually the same as when he had acquired the dam in 1946. There is no record of any action taken. In addition to the seepage that was observed, it is possible that additional seepage was obscured by water escaping from the spillway outlet channel and flowing along the toe of the dam.

The downstream slope of the dam at the surveyed section was found to be about 1V on 1.75H. This agrees with record data that indicate that the downstream slope was never finished to the approved design slope of 1V on 2H. No slides or sloughs on the downstream slope and no cracks on the top of the embankment were evident during the visual inspection. However, bulges that might have existed would have been obscured by the thick growth of brush. An inspection report by the Commonwealth in 1927 noted that there were cracks along the downstream edge of the top of the dam and that slight sloughing had occurred. Later correspondence contained numerous requests to flatten the slope to 1V on 2H, but there was no mention of any slope failures having occurred.

(3) Appurtenant Structures. Erosion of the grouted stone apron downstream from the spillway weir apparently began shortly after the dam was completed. There are no records of repairs. The existing condition is probably the result of progressive deterioration and

erosion over the last 52 years. The existing condition is potentially hazardous. The loss of material at the downstream toe of the weir adversely affects the stability of that structure. . The spillway outlet channel does not adequately confine even small spillway discharge. Flow that escapes and flows along the toe of the embankment obscures seepage and creates an erosion hazard.

b. Design and Construction Data. No stability analyses were available for the embankment. A stability analysis was available for the spillway weir. It is shown on Plate E-2. The only forces considered were water pressure on the upstream side and the weight of the structure. Neither earth pressure nor uplift loads were considered. The resultant was within the middle third of the base. For this report, the stability of the structure was checked under both normal and maximum loading conditions. Earth pressure and uplift were included in the analyses. For the maximum loading condition, pool level at top of dam, the resultant was found to be outside of the middle third of the base, but located within the base about 2.0 feet from the toe. The resulting toe pressure, 0.9 ton per square foot, is probably not excessive for the foundation. The resistance to sliding was found to be questionable for the assumed maximum loading conditions. Therefore, the spillway weir does not meet the guidelines of the Office of the Chief of Engineers (OCE) for stability under the assumed maximum loading conditions. For the normal loading condition, pool level at spillway crest, the structure was found to meet OCE guidelines for stability. It is noted that the analyses were based on a number of assumptions concerning material properties and that the results are only approximate.

c. Operating Records. There are no formal records of operation. According to available data, no stability problems have occurred over the operational history of the dam.

d. Post-construction Changes. Post-construction changes are described in Paragraph 1.2g. The changes are not considered to have significantly affected the stability of the embankment or of the spillway weir.

e. Seismic Stability. Because the stability of the spillway weir is questionable, it is assumed that the dam could not withstand an earthquake.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on available records, visual inspection, calculations, and past operational performance, Shawnee Dam is judged to be in poor condition. Based on existing conditions, the spillway will pass about 38 percent of the PMF before overtopping of the dam occurs. If the low area on the top of the dam were filled to the design elevation, the spillway would pass about 41 percent of the PMF. For either condition, it is judged that the dam could not withstand the depth and duration of overtopping that would occur for the 1/2 PMF. Failure of the dam would cause an increased hazard for loss of life downstream. The spillway capacity is rated as seriously inadequate. According to criteria established for these studies, the dam is judged to be unsafe, non-emergency, because the spillway capacity is seriously inadequate.

(2) No stability problems were evident for the embankment at the time of the visual inspection, but a potential hazard exists due to significant seepage at and near the toe of the dam.

(3) The spillway weir meets OCE guidelines for stability under the normal operating condition, but not under the assumed maximum loading condition. Under the assumed maximum loading, the ability of the weir to resist failure by sliding is questionable. Erosion of material that has occurred at the toe of the weir adversely affects the stability of the structure.

(4) The ability of the outlet works to function is unknown.

(5) Maintenance of the dam and appurtenant structures is inadequate.

(6) A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiency
Embankment:	Low area at abutment; erosion of top at spillway; overgrown with brush and trees; burrowing animal hole; seepage at four locations.
Spillway:	Approach channel obstructed; flashboards; spillway bridge in poor condition; downstream apron severely deteriorated; erosion at toe of weir.
Outlet Works:	Difficult access; not maintained.

b. Adequacy of Information. The information available is such that a preliminary assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will be required.

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, immediately:

(1) Remove flashboards, flashboard pins, fish screens, and fish screen supports from the spillway.

(2) Perform investigations and studies as required to assess the cause and hazard potential of the seepage areas. Take appropriate action as required.

(3) Perform additional studies to more accurately ascertain the spillway capacity required for Shawnee Dam as well as the nature and extent of measures required to provide adequate spillway capacity. The study should also address the deficiencies of the spillway apron and outlet channel. Take appropriate action as required.

(4) Perform additional investigations and studies to more accurately ascertain the structural stability of the spillway weir as well as the nature and extent of measures required to provide adequate factors of safety for structural stability under all loading conditions. Take appropriate action as required.

(5) Ensure the operational adequacy of the outlet works.

(6) Remove trees and brush from the embankment. Upon removal of brush and trees, the embankment should be inspected for bulges, cracks, and other signs of distress. Take appropriate action as required.

(7) Fill low area at top of dam, repair eroded area at top of dam, fill burrowing animal hole, and make repairs to spillway bridge.

All investigations, studies, designs, and supervision of construction should be performed by a professional engineer experienced in the design and construction of dams. Tree removal should be performed under the guidance of a professional engineer.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Shawnee Dam.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of Shawnee Dam.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(4) Institute an inspection program such that the dam is inspected frequently. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(5) Institute a maintenance program so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Shawnee

NDI ID NO.: PA-00629 DER ID NO.: 45-115

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	Available design drawings generally reflect as-built conditions. See Plates E-2 and E-3.
REGIONAL VICINITY MAP	See Plate E-1
CONSTRUCTION HISTORY	Constructed 1926-1927 by Brookside Recreation Club; not completed in accordance with approved plans; spillway bridge raised and flashboards added 1931.
TYPICAL SECTIONS OF DAM	Available - see Plates E-2 and E-3.
OUTLETS: Plan Details Constraints Discharge Ratings	Plan and profile available - see Plate E-2.

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None.
DESIGN REPORTS	Permit application reports for original design (1926) and later modifications (1930). Contains general descriptions of proposed features.
GEOLOGY REPORTS	Test pit data shown on original design drawing - see Plate E-2.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	Spillway capacity estimated for permit application reports. Spillway stability analysis shown on original design drawing - see Plate E-2.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	Visual classification of soil in test pits - see Plate E-2.
POSTCONSTRUCTION SURVEYS OF DAM	None.

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Left hillside adjacent to site; borrow obtained during road relocation.
MONITORING SYSTEMS	None.
MODIFICATIONS	Embankment not completed in accordance with plans; spillway bridge raised and flashboards added 1931.
HIGH POOL RECORDS.	None.
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	Permit application report for 1931 modifications.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None recorded.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	None.
SPILLWAY: Plan Sections Details	See Plates E-2 and E-3.
OPERATING EQUIPMENT: Plans Details	See Plate E-2.
PREVIOUS INSPECTIONS Dates Deficiencies	1927: Downstream slope steep; horizontal cracks along downstream edge of crest with slight sloughing; large leak from ground along outside of downstream masonry sidewall of wasteway channel downstream from toe of fill; riprap in wasteway channel eroded; spillway obstructed with fish screens. 1928: Downstream slope steeper than approved; leakage as noted in 1927; fish screens clogged; swampy at toe; paved apron leaks. 1929: Downstream slope too steep; seepage through embankment at right end 8.5' below top; seepage along toe; undermining of rt. abutment of wasteway; spillway obstructed.

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (Cont'd).	1931: No compliance with request to flatten downstream slope; general seepage along toe; flashboards installed; right abutment of wasteway undermined. 1932: Bridge raised; no compliance with request for downstream slope. 1933: No compliance with request for slope. 1934: No compliance for slope; seepage all along toe; small trickle near right end (reported to be a spring); brush on slopes. 1935: Upstream and downstream slopes too steep; leakage near right end; seepage left of blowoff; flashboards in place; swampy at toe. 1936: Slopes too steep; swampy at toe; leakage at right end and at blowoff; downstream wall of wasteway undermined. 1937: Slopes steep; brush; leakage to right of blowoff; downstream cutoff wall undermined; swampy to right of blowoff. 1941: No compliance with request to flatten slopes; leakage between blowoff and wasteway; wet and swampy at toe from 35' right of blowoff to right end of dam; wasteway riprap badly displaced and cutoff undermined. 1949: Brush and trees on slopes; swampy at toe. 1957: No deficiencies noted. 1965: No deficiencies noted. 1969: Unauthorized flashboards; brush and trees; considerable leakage at end of outlet conduit

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Shawnee County: Monroe State: Pennsylvania

NDI ID No.: PA-00629 DER ID No.: 45-115

Type of Dam: Earthfill with Core Wall Hazard Category: High

Date(s) Inspection: 13 November 1979 Weather: Overcast Temperature: 50°

Pool Elevation at Time of Inspection: 440.0 msl/Tailwater at Time of Inspection: 417.8 msl

Inspection Personnel:

A.H. Whitman (GFCC) H. Loss (Grounds Supt. for Owner)

D.R. Ebersole (GFCC)

D.B. Wilson (GFCC) Recorder

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No cracks observed. One burrowing animal hole 4' above toe at 20' left of outlet conduit.	Top of dam is paved for use as access road.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None apparent.	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	Erosion at top of dam at left abutment of spillway. No other erosion apparent.	
CREST ALIGNMENT: Vertical Horizontal	See Survey Data on Sheet B-9.	
RIPRAP FAILURES	No failures apparent. Riprap does not extend to top of dam.	

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	Embankment erosion at left abutment of spillway. Other abutments had no deficiencies.	
ANY NOTICEABLE SEEPAGE	See Exhibit B-1 for locations and quantities of seepage.	All observed seepage was clear but some points were discharging forcefully.
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	
TREES - BRUSH	Entire upstream and downstream slopes covered with thick brush and trees. Tree size: sapling to 18" Dia.	One 12" Dia. dead tree located at toe of dam at outlet conduit.

B-3

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	30" Dia. concrete conduit; slight flow; downstream end appeared satisfactory.	Could not inspect interior of conduit due to flow of water.
INTAKE STRUCTURE	Located in reservoir area; access only by boat.	Could not inspect. Some external deterioration visible from top of dam.
OUTLET STRUCTURE	Concrete encased conduit. No deficiencies apparent.	
OUTLET CHANNEL	Natural stream channel.	
EMERGENCY GATE	Gate located at intake structure - not accessible for inspection.	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete in good condition.	Flashboards on crest of right bay; pins on crest of center bay; flashboards displaced on crest left bay.
APPROACH CHANNEL	Reservoir area; fish screens and fish screen supports obstruct channel; also some floating debris.	Concrete slightly deteriorated on right approach wall.
DISCHARGE CHANNEL	Large loose rocks; remnants of grouted stone apron and cutoff wall; slight amount of debris. Flow escapes from main channel to toedam.	Concrete deteriorated on both walls on downstream side of weir.
BRIDGE AND PIERS	Steel beam - wooden deck bridge across spillway in poor condition. 2 piers in spillway channel.	Some spalling and disintegration of concrete at each end of piers.

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	Wooded; fairly narrow valley.	
SLOPES	Vary from mild to steep; no evidence of instability.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Estimated 10-15 dwellings would be flooded between dam and Delaware River.	Shawnee Cr. flows through community of Shawnee on Delaware.

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Terrain varies from mountainous to nearly flat.	
SEDIMENTATION	None reported.	
WATERSHED DESCRIPTION	Approx. 60% wooded; 40% grassland; relatively minor amount of residential development.	Camp Sun Mountain Lake Dam is located within watershed upstream from Shawnee Dam.

GANNETT FLEMING CORDDRY
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HARRISBURG, PA.

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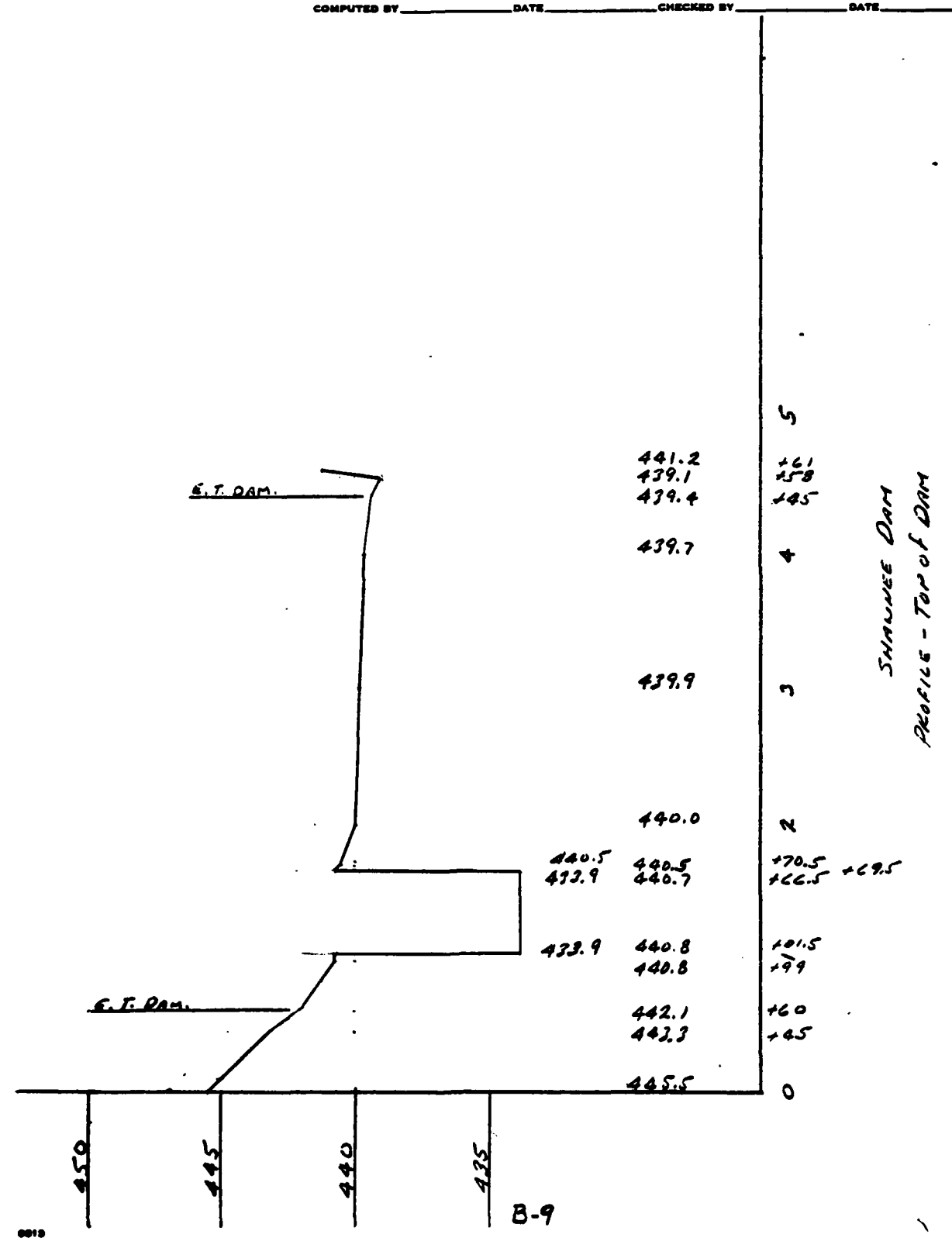

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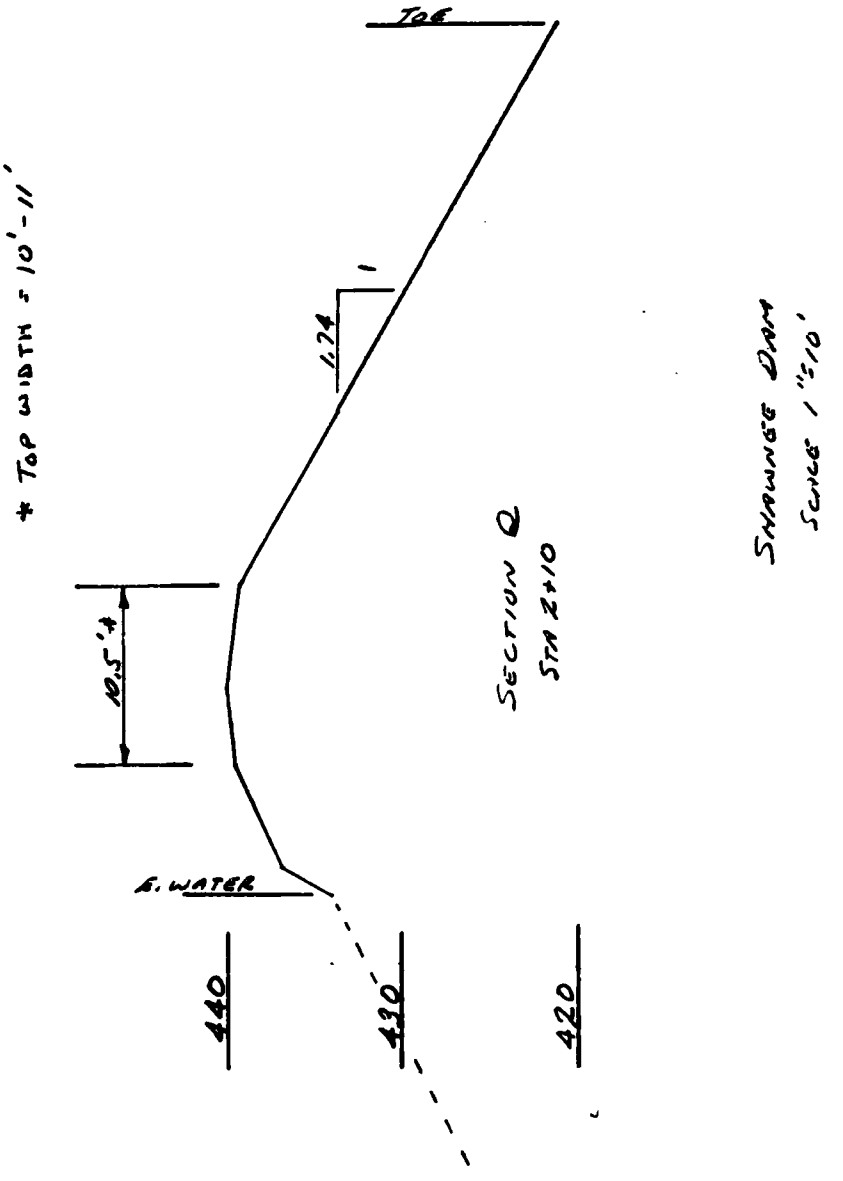

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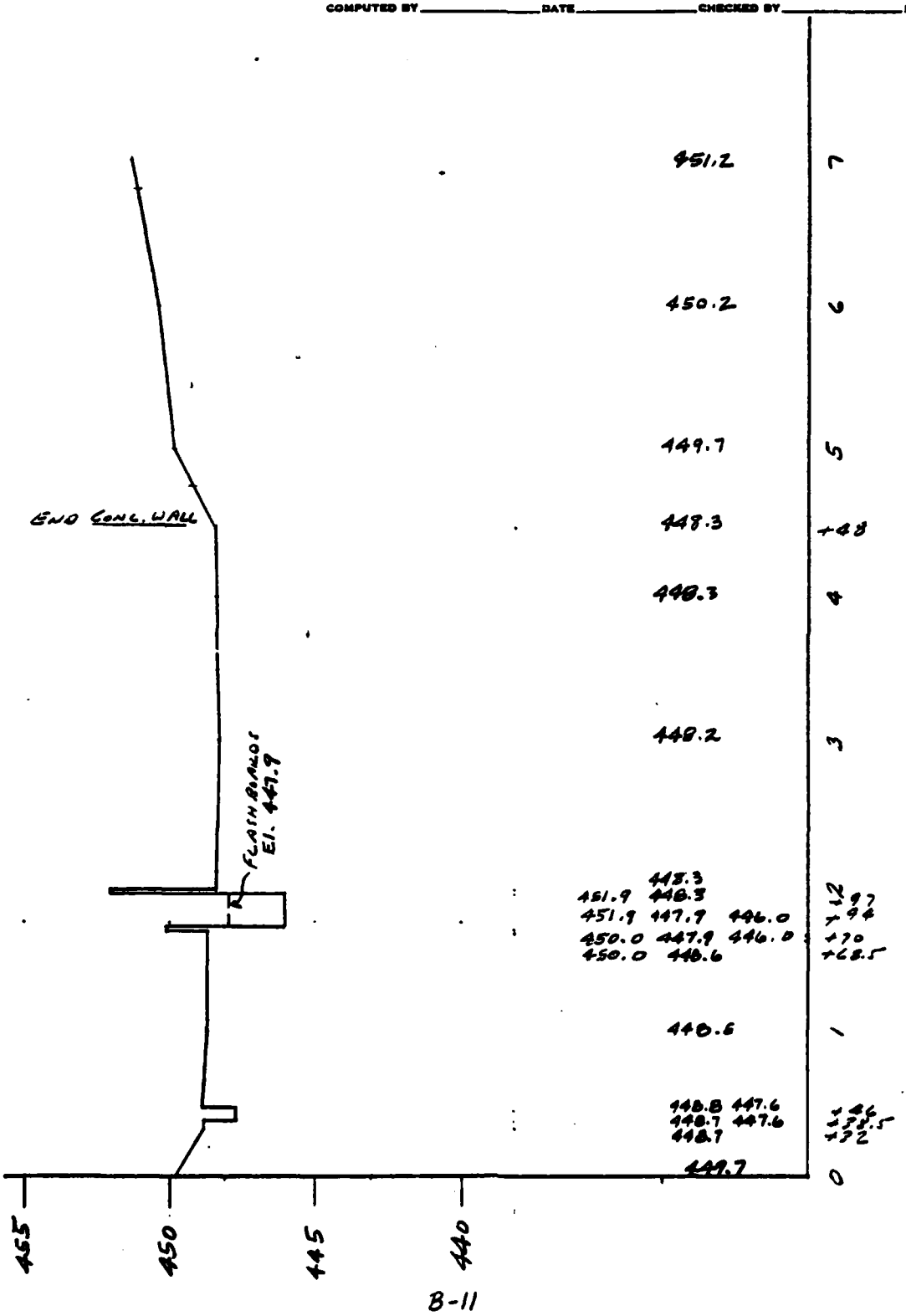
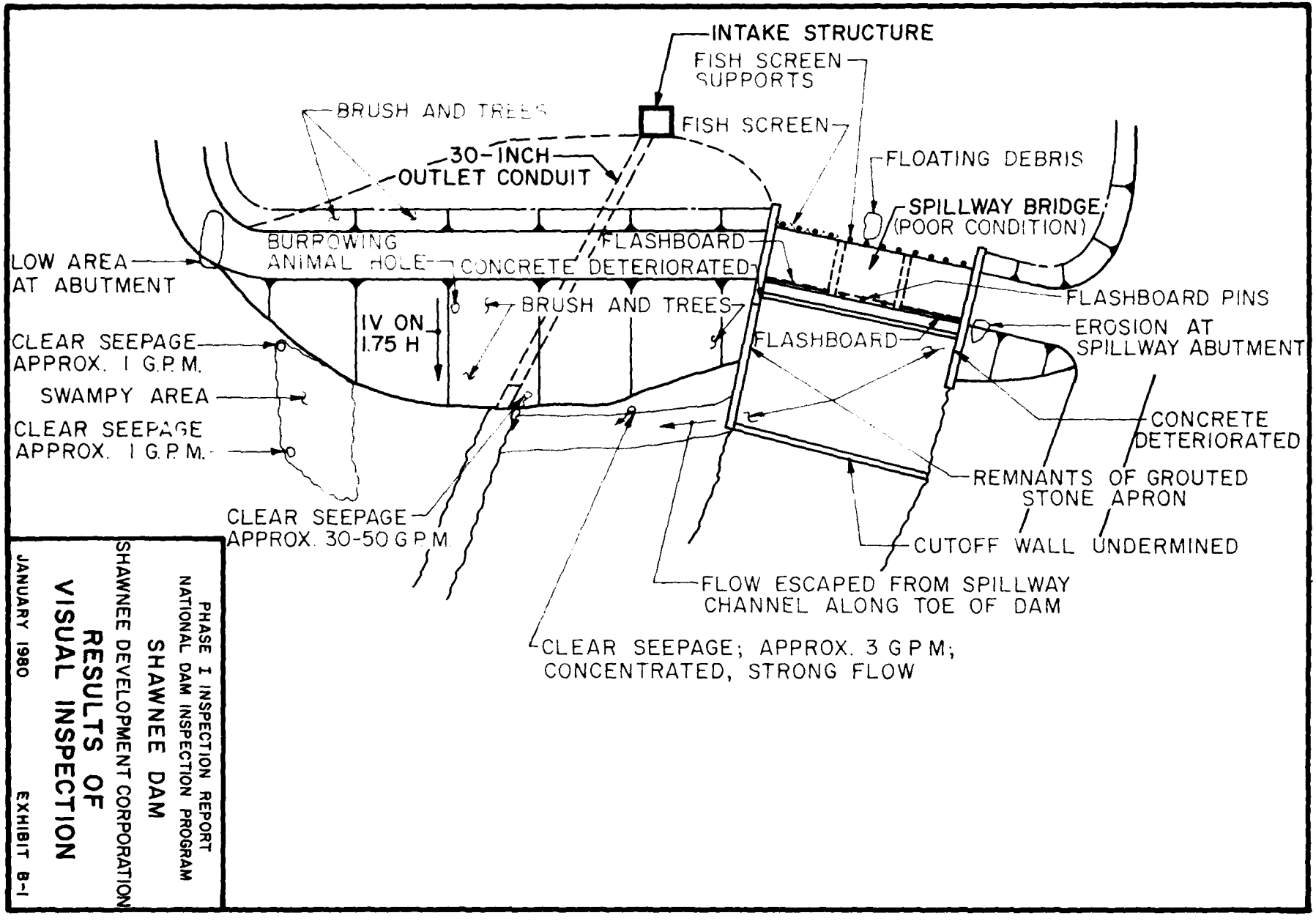


CAMP SUN MOUNTAIN LAKE DAM
PROFILE - TOP OF DAM

B-11

6813



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SHAWNEE DAM

SHAWNEE DEVELOPMENT CORPORATION

RESULTS OF VISUAL INSPECTION

JANUARY 1980

EXHIBIT B-1

APPENDIX C

PHOTOGRAPHS

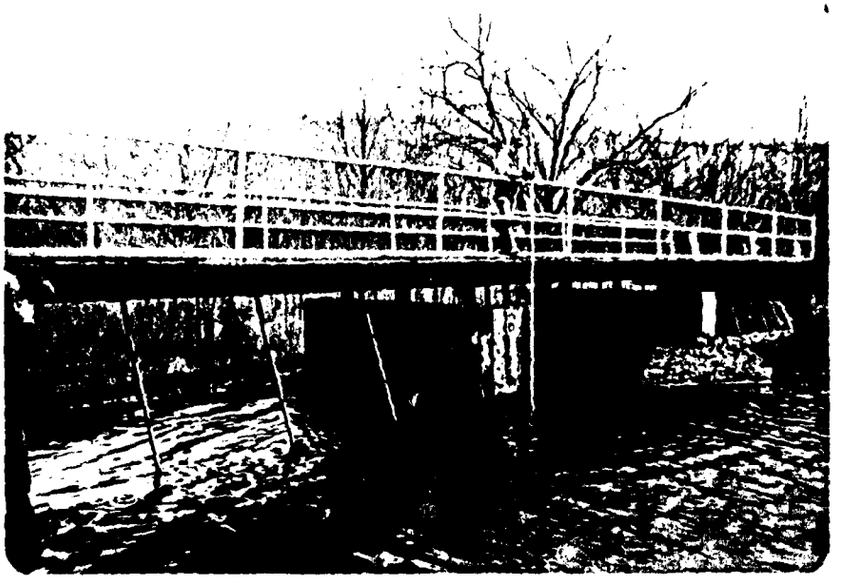
SHAWNEE DAM

A. Top of Dam. View from Left Abutment.

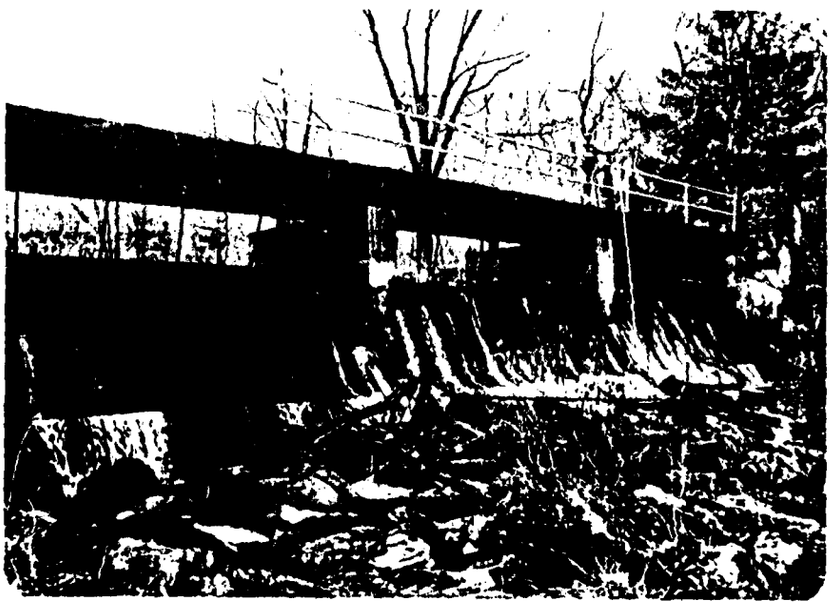
B. Eroded Area Adjacent to Spillway.

C. Upstream Slope.

D. Downstream Slope at Outlet Conduit.



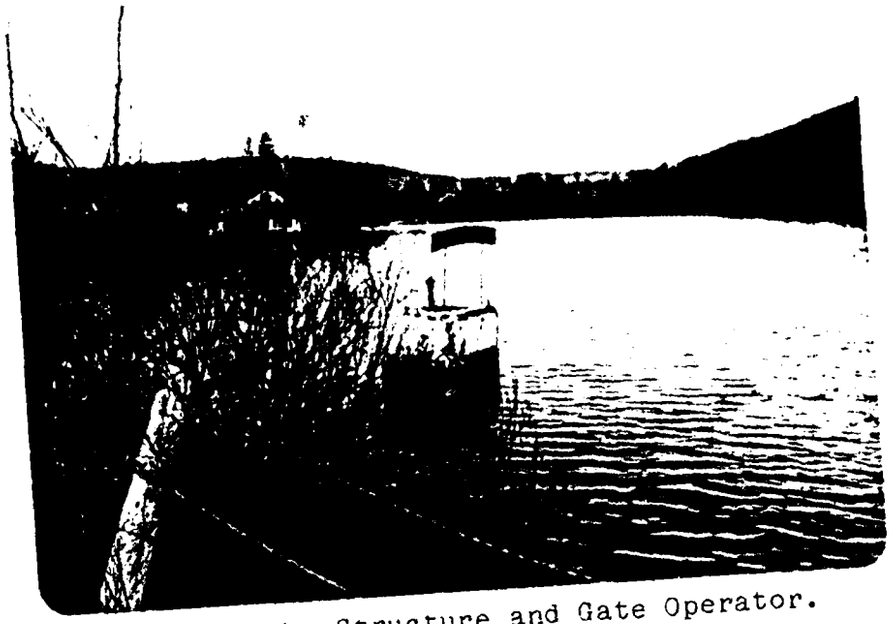
E. Spillway Approach Channel.



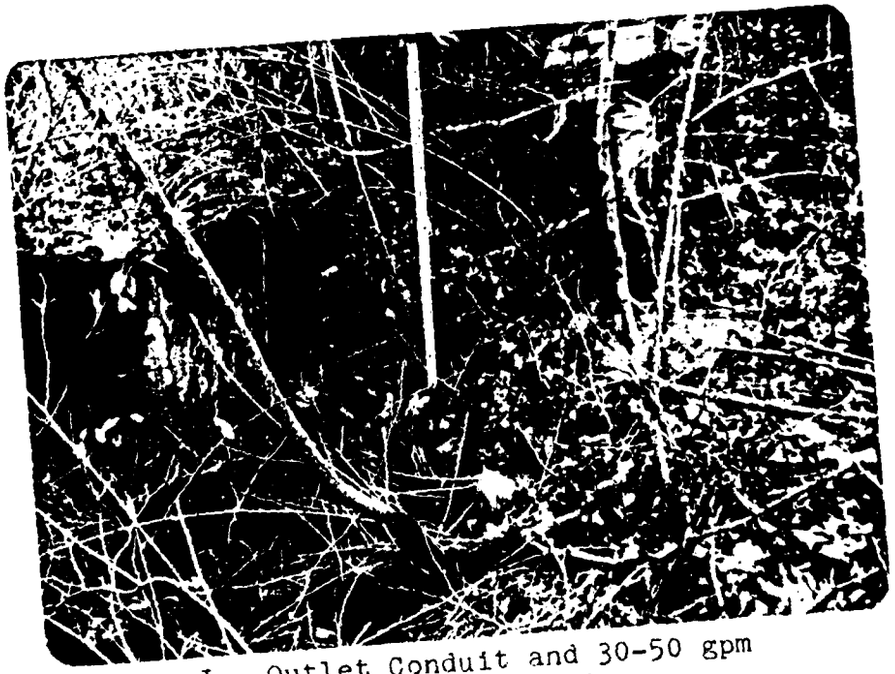
F. Spillway Weir and Apron.

G. Spillway Weir and Apron.

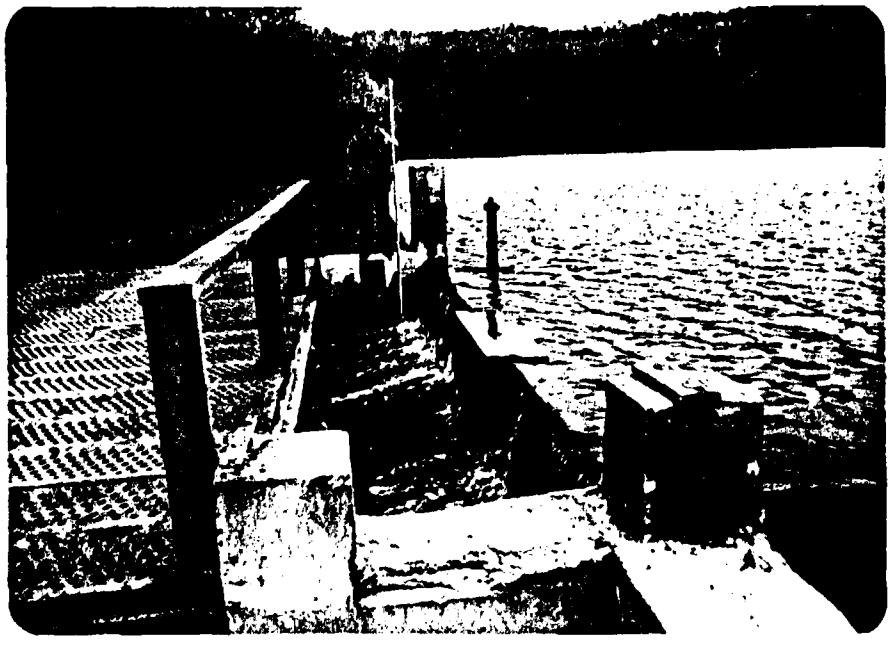
H. Spillway Apron.



I. Intake Structure and Gate Operator.

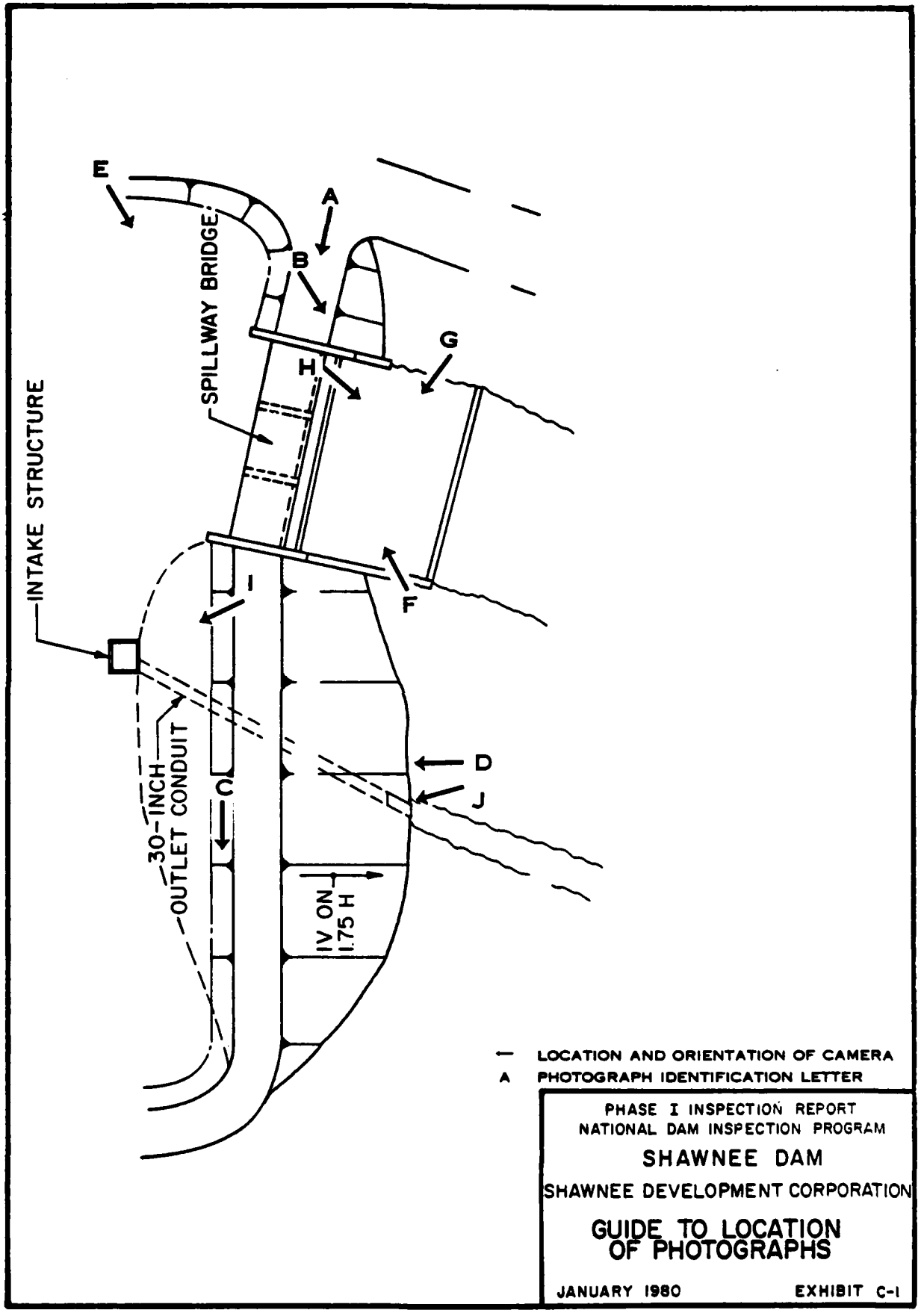


J. Outlet Conduit and 30-50 gpm Seepage at Toe of Dam.



K. Main Spillway of Camp Sun Mountain Lake Dam (Located 0.45 Mile Upstream from Shawnee Dam).

L. Auxiliary Spillway of Camp Sun Mountain Lake Dam (Located 0.45 Mile Upstream from Shawnee Dam).



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SHAWNEE DAM

SHAWNEE DEVELOPMENT CORPORATION

GUIDE TO LOCATION OF PHOTOGRAPHS

JANUARY 1980 EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

Delaware River Basin
Name of Stream: Shawnee Creek
Name of Dam: Shawnee Dam
NDI ID No.: PA-00629
DER ID No.: 45-115
Latitude: N 41° 01' 30" Longitude: W 75° 06' 05"
Top of Dam Elevation: 439.1 (Existing)
Streambed Elevation: 417.4 Height of Dam: 22 ft
Reservoir Storage at Top of Dam Elevation: 132 acre-ft
Size Category: Small
Hazard Category: High (see Section 5)
Spillway Design Flood: Varies from ½ PMF to PMF
Select PMF based on downstream development

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
Camp Sun Mt. Lake Dam	0.45	9	73	DER ID No. 45-162

DOWNSTREAM DAMS

	No downstream dams.			

Name of Stream: Delaware River Basin
Name of Dam: Shawnee Creek
Shawnee Dam

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A-1	3.3	0.45	1.23	3.9	1.5	—	2.1	1	A
A-2	0.5	0.45	1.23	1.1	0.4	—	1.0	1	A
Total	3.8								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

RAINFALL DATA:

PMF Rainfall Index= 22.1 in., 24 hr., 200 sq. mile.

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	1
Geographic Adjustment Factor:	N/A	1.0
Revised Index Rainfall:	N/A	22.1

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	111
12 hours	123
24 hours	133
48 hours	142
72 hours	—
96 hours	—

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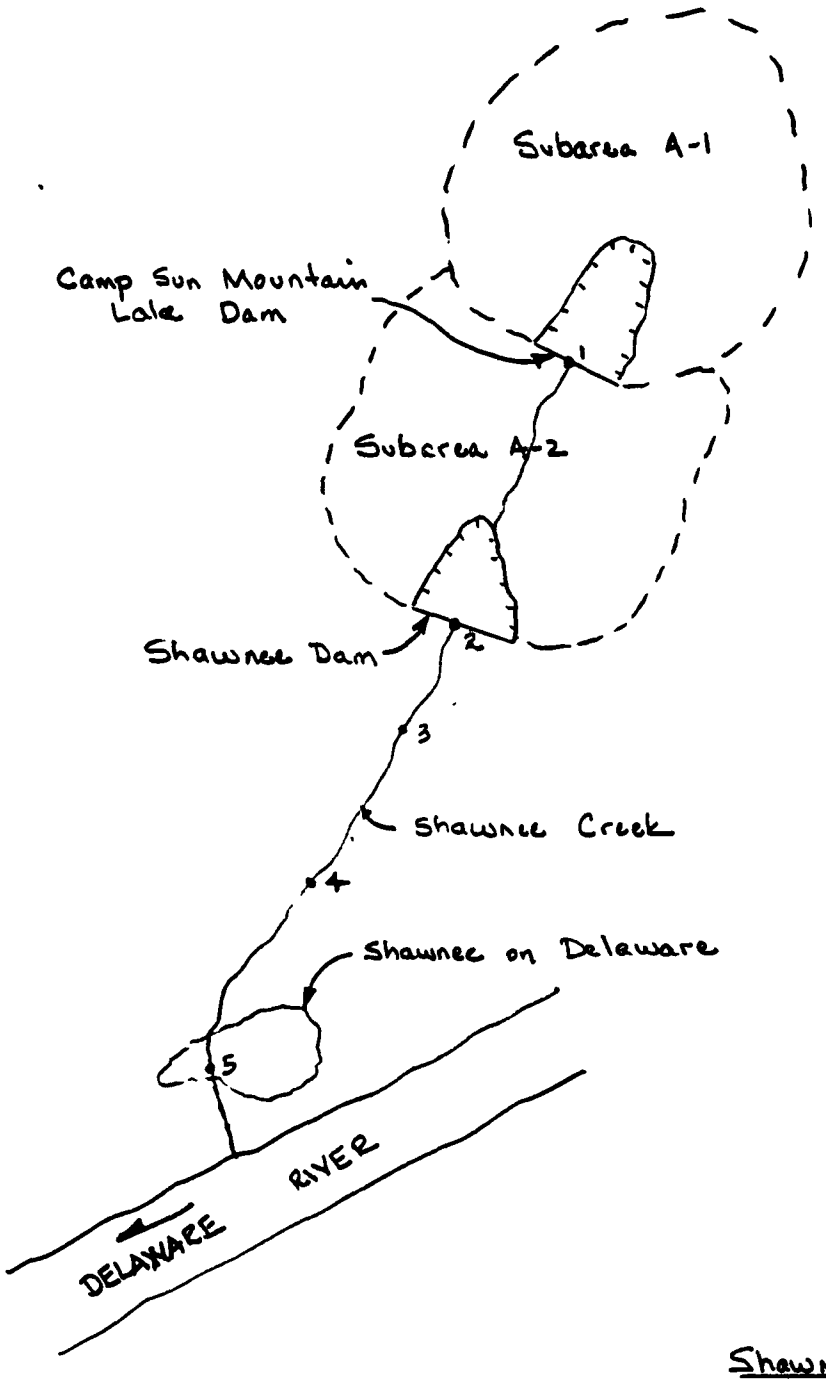
HARRISBURG, PA.

SUBJECT Shawnee Dam FILE NO.
SHEET NO. OF SHEETS
FOR National Dam Inspection Program
COMPUTED BY DATE CHECKED BY DATE



Shawnee Dam
Sketch of System

NOT TO SCALE

6313

Data for Dam at Outlet of Subarea A-1 (see Sketch on Sheet D-4)

Name of Dam: Camp Sun Mountain Lake Dam

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	448.2	N/A
Spillway Crest Elevation	447.9	
Spillway Head Available (ft)	0.3	
Type Spillway	Stop logs	
"C" Value - Spillway	3.1	
Crest Length - Spillway (ft)	24	
Spillway Peak Discharge (cfs)	12	
Auxiliary Spillway Crest Elev.	447.6	
Auxiliary Spill. Head Avail. (ft)	0.6	
Type Auxiliary Spillway	Round-crested	
"C" Value - Auxiliary Spill. (ft)	3.1	
Crest Length - Auxil. Spill. (ft)	7.5	
Auxiliary Spillway Peak Discharge (cfs)	11	
Combined Spillway Discharge (cfs)	23	N/A

Spillway Rating Curve: $Q_c = (3.1)(24)(H)^{3/2}$ (main) $+ (3.1)(7.5)(H_a)^{3/2}$ (auxiliary)

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
447.6	0	0	0
447.9	0	4	4
448.2	12	11	23
450.0	226	86	312
452.0	618	215	833
455.0	1408	440	1848
460.0	3131	1015	4146

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1N^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5}$ = C			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$(cfs)			
Q Combined (cfs)			

N/A FOR ANALYSIS

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: Camp Sun Mountain Lake Dam

STORAGE DATA: Elevations determined from USGS Map.

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
437.4	=ELEVO*	0		0	0		
446.0	=ELEV1	14	=A1	13	40	=S1	DER Records
447.9		16		22	68.5		Top flashboards
448.2		17		24	73.4		Low Pt. - Top of Dam
460.0		51		148	454		

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 1 percent of subarea watershed.

BREACH DATA: Dam not breached for analysis of Shawnee Dam

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-2 (see Sketch on Sheet D-4)

Name of Dam: Shawnee Dam

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	439.1 (Low Pt)	439.4
Spillway Crest Elevation	433.9	433.9
Spillway Head Available (ft)	5.2	5.5
Type Spillway	Concrete ogee	
"C" Value - Spillway	3.88	3.88
Crest Length - Spillway (ft)	61	61
Spillway Peak Discharge (cfs)	2,807	3,050
Auxiliary Spillway Crest Elev.	N/A	N/A
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)	N/A	N/A
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = (3.88)(61)(H)^{3/2}$ (Fish screens & flashboards ignored)

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	417.8		
Invert of Inlet	418.5		
Type	RCP		
Diameter (ft) = D	2.5		
Length (ft) = L	98		
Area (sq. ft) = A	4.9		
N	0.012		
K Entrance	0.5		
K Exit	1.0		
K Friction=$29.1 N^2 L/R^{4/3}$	0.8		
Sum of K	2.3		
$(1/K)^{0.5}$ = C	0.66		
Maximum Head (ft) = HM	20.6		
$Q = CA\sqrt{2g(HM)}$ (cfs)	118		
Q Combined (cfs)	118		

Data for Dam at Outlet of Subarea A-2 (See sketch on Sheet D-4)

Name of Dam: Shawnee Dam

STORAGE DATA:

Elevation		Area (acres)	Storage million gals	Storage acre-ft	Remarks
418.6	=ELEVO*	0	0	0	
433.9	=ELEV1	12.0 =A1	20	61.4 =S1	Spillway Crest
439.1		15.2	43	132.0	Low Pt. - Top of Dam
460.0		83.0	341	1,064.0	

* ELEVO = ELEV1 - $(3S_1/A_1)$
** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 4 percent of subarea watershed.

BREACH DATA: Camp Sun Mountain Lake Dam Assumed Not to Fail.

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: Sandy Clay

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) 2.5 fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = 0.3 ft., C = 3.1 Top of Dam El.= 439.1

HMAX + Top of Dam El. = 439.4 = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = 80 ft (width of bottom of breach)
Z = 1 (side slopes of breach)
ELBM = 420.0 (bottom of breach elevation, minimum of zero storage elevation)
WSEL = 433.9 (normal pool elevation)
T FAIL= 6 mins = 0.1 hrs (time for breach to develop)

Selected Computer Output

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                A1                          NATIONAL DAM INSPECTION PROGRAM
    2                A2                                SHAWNEE CREEK
    3                A3                                SHAWNEE DAM
    4                B     300        0       15        0        0        0        0        0       -4        0
    5                B1      5
    6                J       1        9        1
    7                J1      1      .6       .5       .4       .3       .2       .1      .05      .01
    8                K       0        1                                            1
    9                K1        RUNOFF INTO CAMP SUN MOUNTAIN
   10                M       1        1      3.3                3.8                                        1
   11                P                22.1      111      123      133      142
   12                T                                                           1.0      .05                .01
   13                W     2.1      .45
   14                X    -1.5    -0.05      2.0
   15                K       1        1                                            1
   16                K1        ROUTE THROUGH CAMP SUN MOUNTAIN DAM
   17                Y                                        1
   18                Y1      1                                                  -447.6       -1
   19                Y4  447.6    447.9    448.2      450      452      455      460
   20                Y5      0        4       23      312      833     1848     4146
   21                SA      0       14       16       17       51
   22                SE  437.4      446    447.9    448.2      460
   23                SS  447.6
   24                SD  448.2
   25                SL      1      251      409      519      679      679
   26                SV  448.2    448.3      449      450      451      460
   27                K       0        2                                            1
   28                K1        RUNOFF INTO SHAWNEE LAKE(UNCONTROLLED)
   29                M       1        1      0.5                3.8                                        1
   30                P                22.1      111      123      133      142
   31                T                                                           1.0      .05                .04
   32                W     1.0      0.45
   33                X    -1.5    -0.05      2.0
   34                K       2        2                                            1
   35                K1        COMBINE SHAWNEE AND CAMP SUN MOUNTAIN
   36                K       1        2                                            1
   37                K1        ROUTE THROUGH SHAWNEE LAKE
   38                Y                                        1
   39                Y1      1                                                  -433.9
   40                SA      0       12     15.2       83
   41                SE  418.6    433.9    439.1      460
   42                SS  433.9       61     3.88      1.5
   43                SD  439.1
   44                SL      1       12       58      158      260      295      340      390      400
   45                SV  439.1    439.4    439.7    439.9      440    440.7      442      445      450
   46                K      99
```

D-9

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .60	RATIO 3 .50	RATIO 4 .40	RATIO 5 .30	RATIO 6 .20	RATIO 7 .10	RATIO 8 .05	RATIO 9 .01
HYDROGRAPH AT	1	3.30	1	6387.	3832.	3193.	2555.	1916.	1277.	639.	319.	64.
	(	8.55)	(	180.85)(	108.51)(	90.43)(	72.34)(	54.26)(	36.17)(	18.09)(	9.04)(	1.81)
ROUTED TO	1	3.30	1	6386.	3832.	3193.	2554.	1915.	1276.	636.	317.	58.
	(	8.55)	(	180.84)(	108.51)(	90.42)(	72.32)(	54.23)(	36.13)(	18.02)(	8.98)(	1.64)
HYDROGRAPH AT	2	.50	1	1453.	872.	727.	581.	436.	291.	145.	73.	15.
	(	1.29)	(	41.15)(	24.69)(	20.58)(	16.46)(	12.35)(	8.23)(	4.12)(	2.06)(	.41)
2 COMBINED	2	3.80	1	7524.	4510.	3756.	3002.	2249.	1497.	746.	371.	66.
	(	9.84)	(	213.07)(	127.70)(	106.36)(	85.00)(	63.69)(	42.39)(	21.13)(	10.52)(	1.86)
ROUTED TO	2	3.80	1	7505.	4500.	3746.	2981.	2232.	1483.	737.	364.	60.
	(	9.84)	(	212.53)(	127.44)(	106.07)(	84.42)(	63.19)(	41.98)(	20.87)(	10.30)(	1.71)

SUMMARY OF DAM SAFETY ANALYSIS

CAMP SUN MOUNTAIN LAKE DAM

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	447.60	447.60	448.20
STORAGE	64.	64.	74.
OUTFLOW	0.	0.	23.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	450.93	2.73	129.	6386.	46.75	42.00	0.00
.60	450.26	2.06	113.	3932.	44.25	42.00	0.00
.50	450.06	1.86	109.	3193.	41.75	42.00	0.00
.40	449.84	1.64	104.	2554.	38.50	42.00	0.00
.30	449.58	1.38	99.	1915.	32.75	42.00	0.00
.20	449.29	1.09	93.	1276.	26.75	42.00	0.00
.10	448.92	.72	86.	636.	22.00	42.00	0.00
.05	448.66	.46	82.	317.	16.00	42.00	0.00
.01	448.32	.12	76.	58.	6.50	43.00	0.00

D-12

SUMMARY OF DAM SAFETY ANALYSIS

SHAWNEE DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	433.90	433.90	439.10
STORAGE	61.	61.	172.
OUTFLOW	0.	0.	2807.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	441.70	2.60	179.	7505.	7.25	42.00	0.00
.60	440.49	1.39	155.	4500.	4.25	42.00	0.00
.50	440.06	.96	147.	3746.	3.25	42.00	0.00
.40	439.31	.21	135.	2981.	1.50	42.00	0.00
.30	438.36	0.00	121.	2232.	0.00	42.00	0.00
.20	437.30	0.00	105.	1483.	0.00	42.25	0.00
.10	436.03	0.00	88.	737.	0.00	42.25	0.00
.05	435.23	0.00	78.	364.	0.00	42.50	0.00
.01	434.30	0.00	66.	60.	0.00	43.50	0.00

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
```

```
    1    A1                                  NATIONAL DAM INSPECTION PROGRAM
    2    A2                                        SHAWNEE CREEK
    3    A3                                        SHAWNEE DAM
    4    B     300        0        6        0        0        0        0        0       -4        0
    5    B1      5
    6    J       2        1        1
    7    J1    .5
    8    K       0        1                                                  1
    9    K1        RUNOFF INTO CAMP SUN MOUNTAIN
   10    M       1        1      3.3              3.9                                    1
   11    P               22.1      111      123      133
   12    T                                                                1.0      .05               .01
   13    W     2.1      .45
   14    X    -1.5    -0.05      2.0
   15    K       1        1                                                  1
   16    K1        ROUTE THROUGH CAMP SUN MOUNTAIN DAM
   17    Y                                         1        1
   18    Y1      1                                                       -447.6       -1
   19    Y4  447.6    447.9    448.2      450      452      455      460
   20    Y5      0        4       23      312      833     1948     4146
   21    SA      0       14       16       17       51
   22    SE  437.4      446    447.9    449.2      460
   23    SS  447.6
   24    SD  448.2
   25    SL      1      251      409      519      679      679
   26    SV  448.2    448.3      449      450      451      460
   27    K       0        2                                                  1
   28    K1        RUNOFF INTO SHAWNEE LAKE(UNCONTROLLED)
   29    M       1        1      0.5              3.8                                    1
   30    P               22.1      111      123      133
   31    T                                                                1.0      .05               .04
   32    W     1.0      0.45
   33    X    -1.5    -0.05      2.0
   34    K       2        2                                                  1
   35    K1        COMBINE SHAWNEE AND CAMP SUN MOUNTAIN
   36    K       1        2                                                  1
   37    K1        ROUTE THROUGH SHAWNEE LAKE
   38    Y                                         1        1
   39    Y1      1                                                       -433.9
   40    SA      0       12     19.2       83
   41    SE  418.6    433.9    439.1      440
   42    SS  433.9       61     3.38      1.5
   43    SD  439.1
   44    SL      1       12       58      158      260      295      340      390      400
   45    SV  439.1    439.4    439.7    439.9      440    440.7      442      445      450
   46    SB     80        1      420       .1    443.9    450.0
   47    SR     80        1      420       .1    443.9    439.4
   48    K       1        2                                                  1
   49    K1        STREAM X-SECT
                                                 1        1
```

```
Y1      1                                                     -1
Y6   .09     .07     .09     400     430    1400  .0235
Y7      0    500     240     440     400     410    450     400     465     400
Y7    670    470     610     440     650     460
K       1      4                                          1
K1        STREAM X-SECT
Y                            1       1
Y1      1                                                     -1
Y6   .09     .07     .09     366     400    2400  .0148
Y7      0    480     300     400     450     380    500     366     515     366
Y7    650    380     750     400     910     420
K       1      5                                          1
K1        STREAM X-SECT AT SHAWNEE-ON-DELAWARE
Y                            1       1
Y1      1                                                     -1
Y6   .09     .07     .09     314     340    1950   .025
Y7      0    360      50     340     206     120    320     314     235     314
Y7    400    320     450     340     520     360
K      99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50
HYDROGRAPH AT	1	3.30	1	3172.
		(8.55)		(89.82)(
			2	3172.
				(89.82)(
ROUTED TO	1	3.30	1	3167.
		(8.55)		(89.68)(
			2	3167.
				(89.68)(
HYDROGRAPH AT	2	.50	1	730.
		(1.29)		(20.66)(
			2	730.
				(20.66)(
2 COMBINED	2	3.80	1	3738.
		(9.84)		(105.86)(
			2	3738.
				(105.86)(
ROUTED TO	2	3.80	1	3721.
		(9.84)		(105.36)(
			2	18004.
				(509.82)(
ROUTED TO	3	3.80	1	3721.
		(9.84)		(105.36)(
			2	12485.
				(353.53)(
ROUTED TO	4	3.80	1	3717.
		(9.84)		(105.25)(
			2	11543.
				(326.86)(
ROUTED TO	5	4.30	1	3716.
		(9.94)		(105.24)(
			2	10080.
				(285.42)(

SUMMARY OF DAM SAFETY ANALYSIS

CAMP SUN MOUNTAIN LAKE DAM

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	447.60	447.60	449.20
STORAGE	64.	64.	74.
OUTFLOW	0.	0.	23.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	450.06	1.86	109.	3167.	20.50	17.80	0.00

PLAN 2 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	447.60	447.60	448.20
STORAGE	64.	64.	74.
OUTFLOW	0.	0.	23.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	450.06	1.86	109.	3167.	20.50	17.80	0.00

SUMMARY OF DAM SAFETY ANALYSIS

SHAWNEE DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	433.90	433.90	439.10
STORAGE	61.	61.	132.
OUTFLOW	0.	0.	2807.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	440.04	.94	147.	3721.	3.20	17.80	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	433.90	433.90	439.10
STORAGE	61.	61.	132.
OUTFLOW	0.	0.	2807.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	439.50	.40	138.	16604.	.34	17.00	16.90

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	3721.	466.8	17.90

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	12485.	411.2	17.10

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	3717.	373.9	18.00

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	11443.	376.7	17.10

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	3716.	320.8	18.00

PLAN 2 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	10080.	324.0	17.10

Shawnee Dam
Summary of Pertinent Results

PMF Rainfall = 25.11 inches
PMF Runoff = 22.8 inches

Multi-ratio Analysis :	PMF	½ PMF
Camp Sun Mt. Lake Dam :		
Inflow (cfs)	6,387	3,193
Outflow (cfs)	6,386	3,193
Depth of Overtopping (ft)	2.73	1.86
Duration of Overtopping (hr)	46.8	41.8
Shawnee Dam :		
Inflow (cfs)	7,524	3,756
Outflow (cfs)	7,505	3,746
Depth of Overtopping (ft)	2.60	0.96
Duration of Overtopping (hr)	7.3	3.3

Breach Analysis (½ PMF) - Shawnee Dam

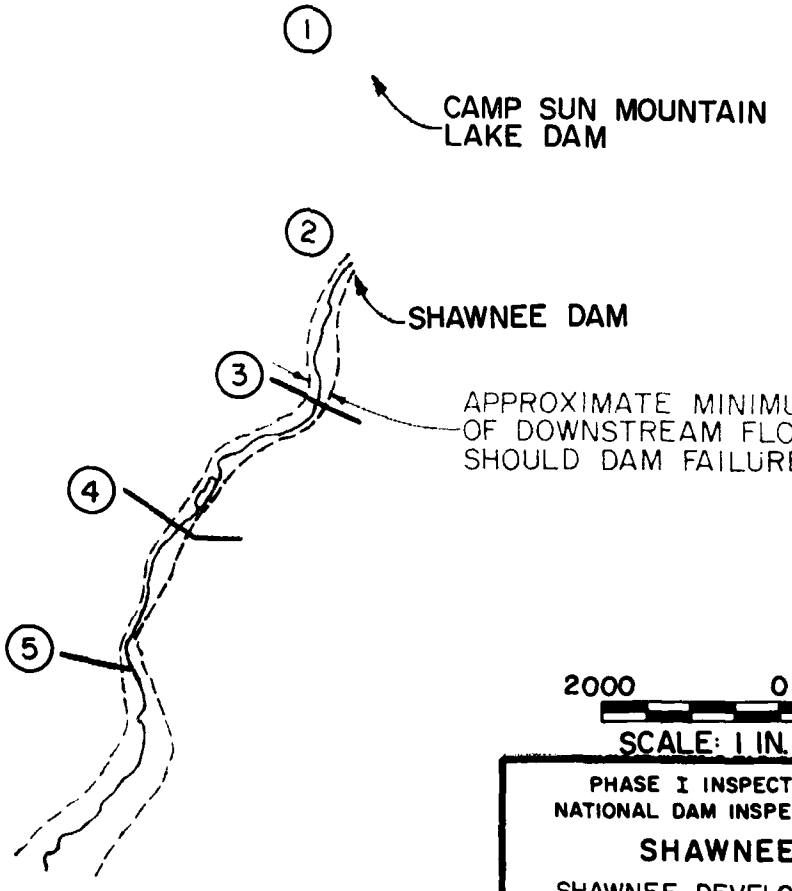
Station Number	Stream Depth (ft) No Failure	Failure	Δ Depth (ft)
3	6.8	11.2	4.4
4	7.9	12.7	4.8
5	6.8	10.0	3.2

Notes:

1. Breach analysis for Shawnee Dam did not consider failure of Camp Sun Mt. Lake Dam
2. Station Number Identification:
   Station 3 : 4 Dwellings
   Station 4 : No Dwellings
   Station 5 : 8 Dwellings

NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.



2000 0 2000

SCALE: 1 IN. = 2000 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SHAWNEE DAM

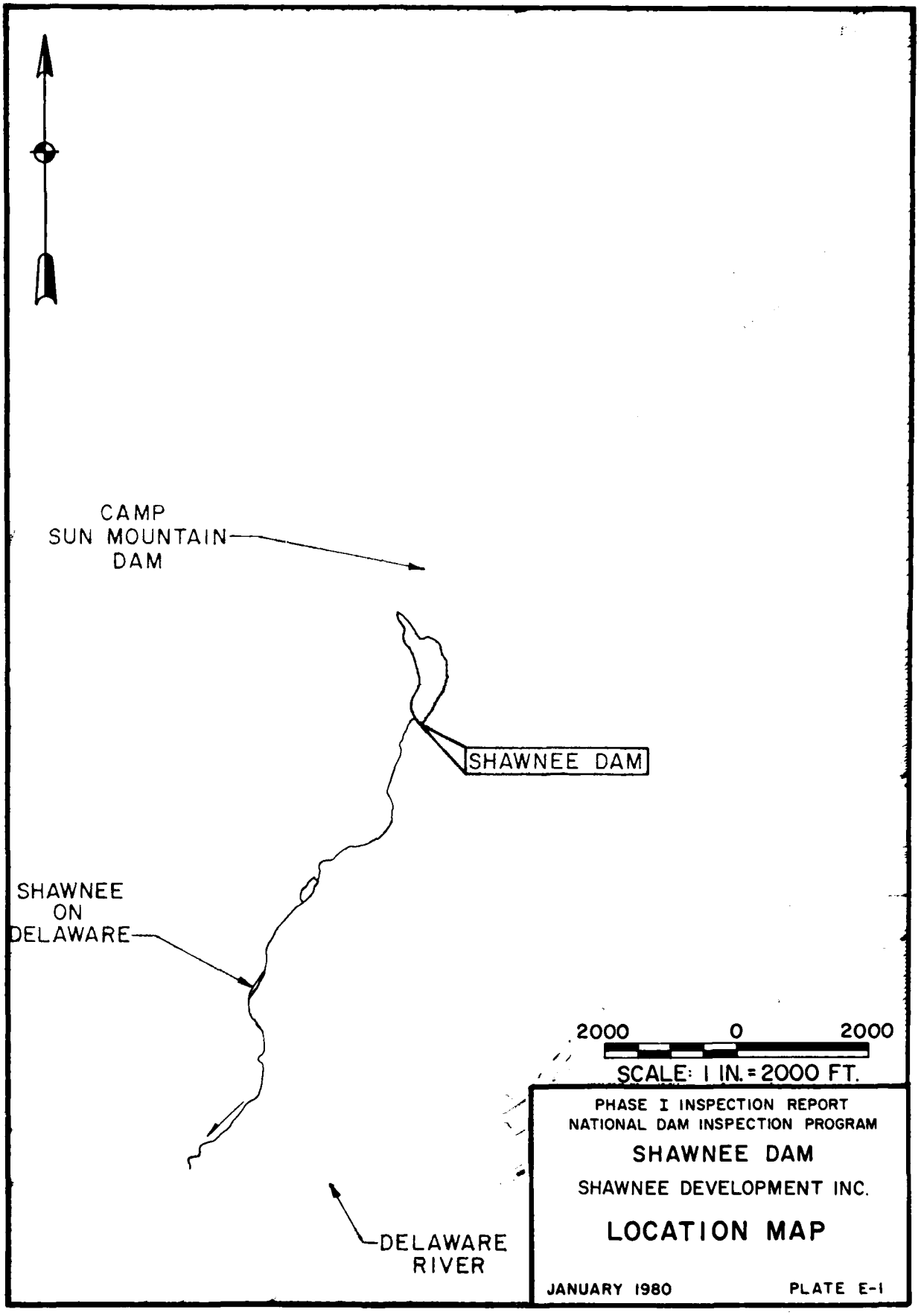
SHAWNEE DEVELOPMENT, INC.

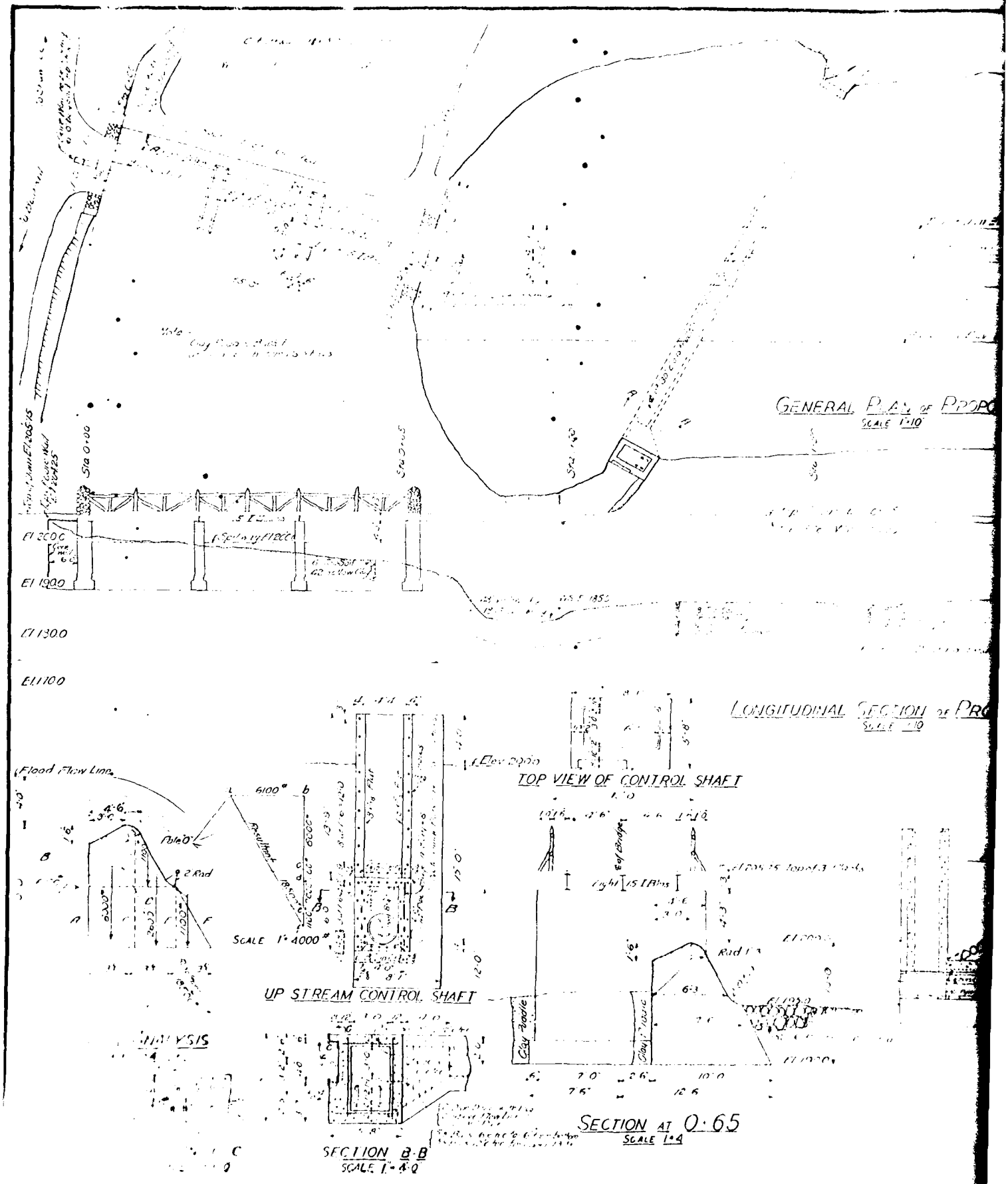
DOWNSTREAM DEVELOPMENT PLAN

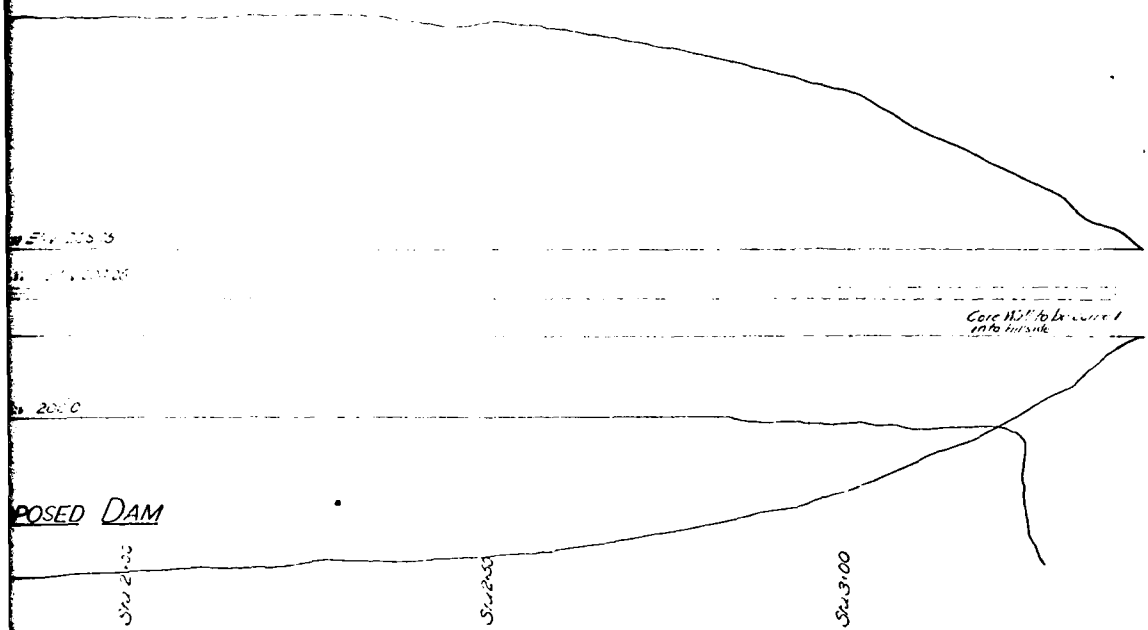
JANUARY 1980 EXHIBIT D-1

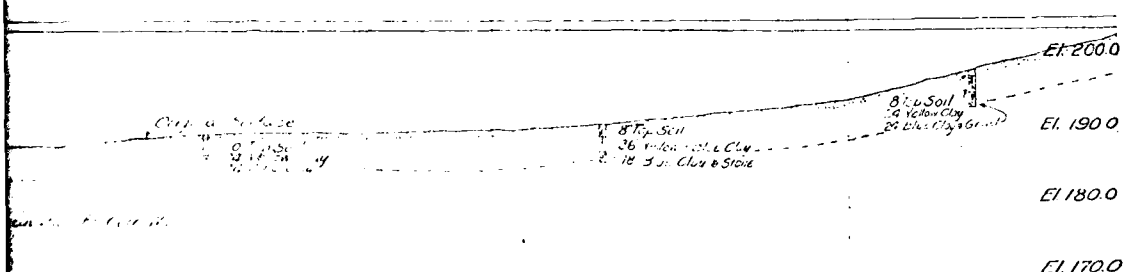
APPENDIX E

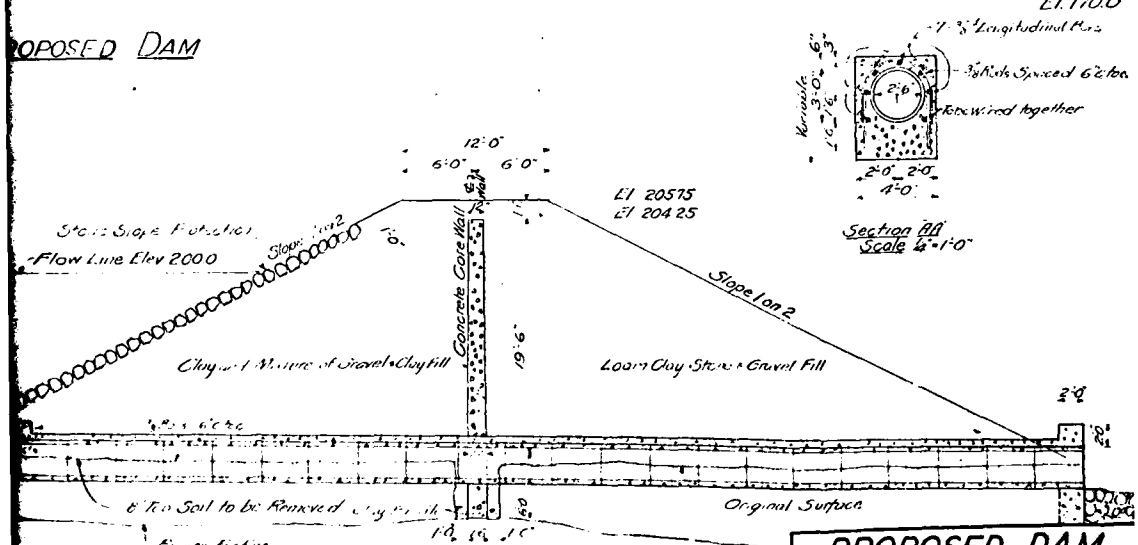
PLATES


CAMP
SUN MOUNTAIN
DAM
SHAWNEE DAM
SHAWNEE
ON
DELAWARE
DELAWARE
RIVER
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
SHAWNEE DAM
SHAWNEE DEVELOPMENT INC.
LOCATION MAP
JANUARY 1980
PLATE E-1


GENERAL PLAN OF PROPO
SCALE 1-10
LONGITUDINAL SECTION OF PRO
SCALE 1-10
TOP VIEW OF CONTROL SHAFT
UP STREAM CONTROL SHAFT
SECTION B-B
SCALE 1-4-0
SECTION AT 0·65
SCALE 1-4
SCALE 1-4000
Flood Flow Line
Pile 0'
2 Rad
Sta 0+00
EL 2000
EL 1900
EL 1300
EL 1100
Clay Backfill
Clay Puddle

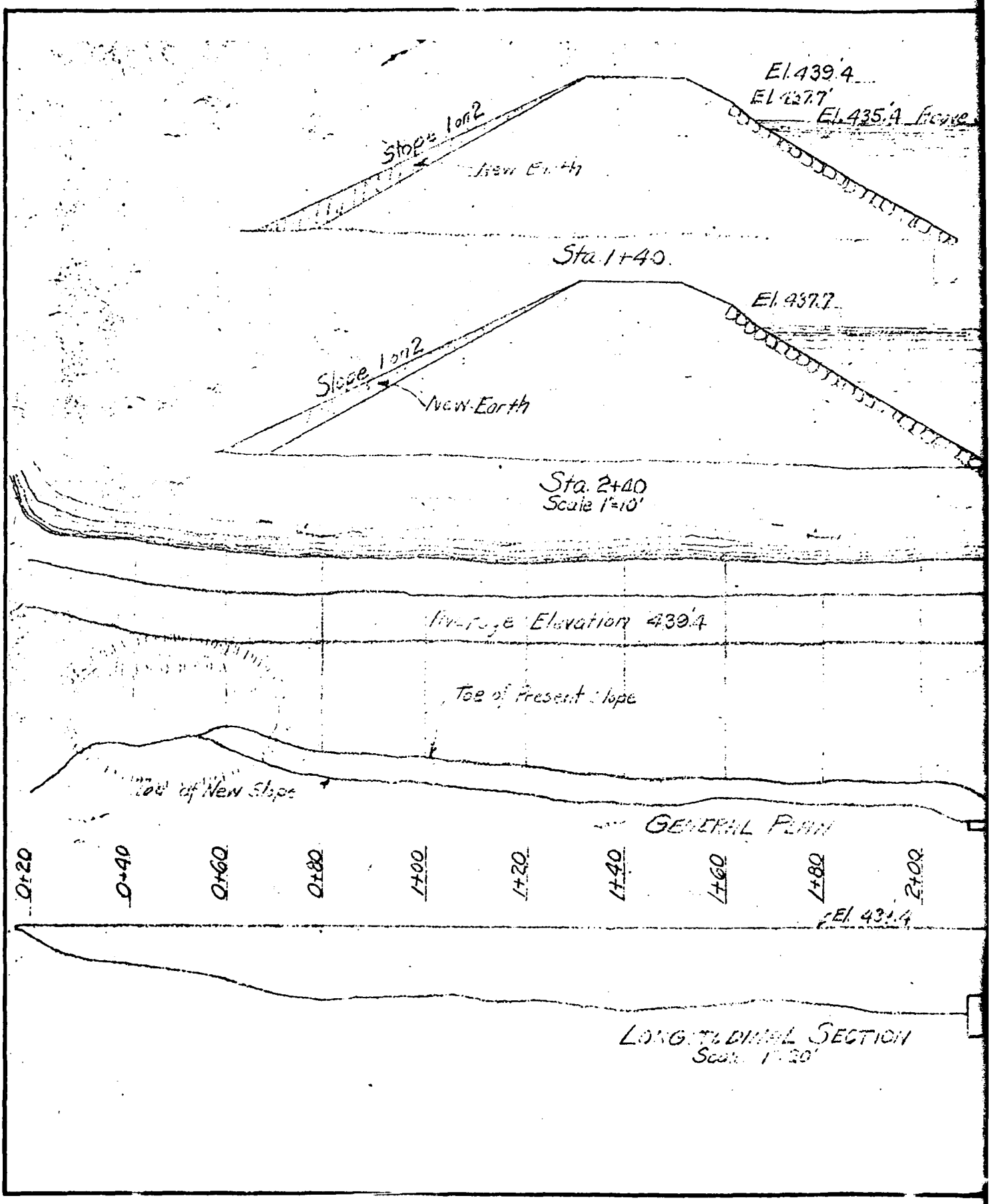


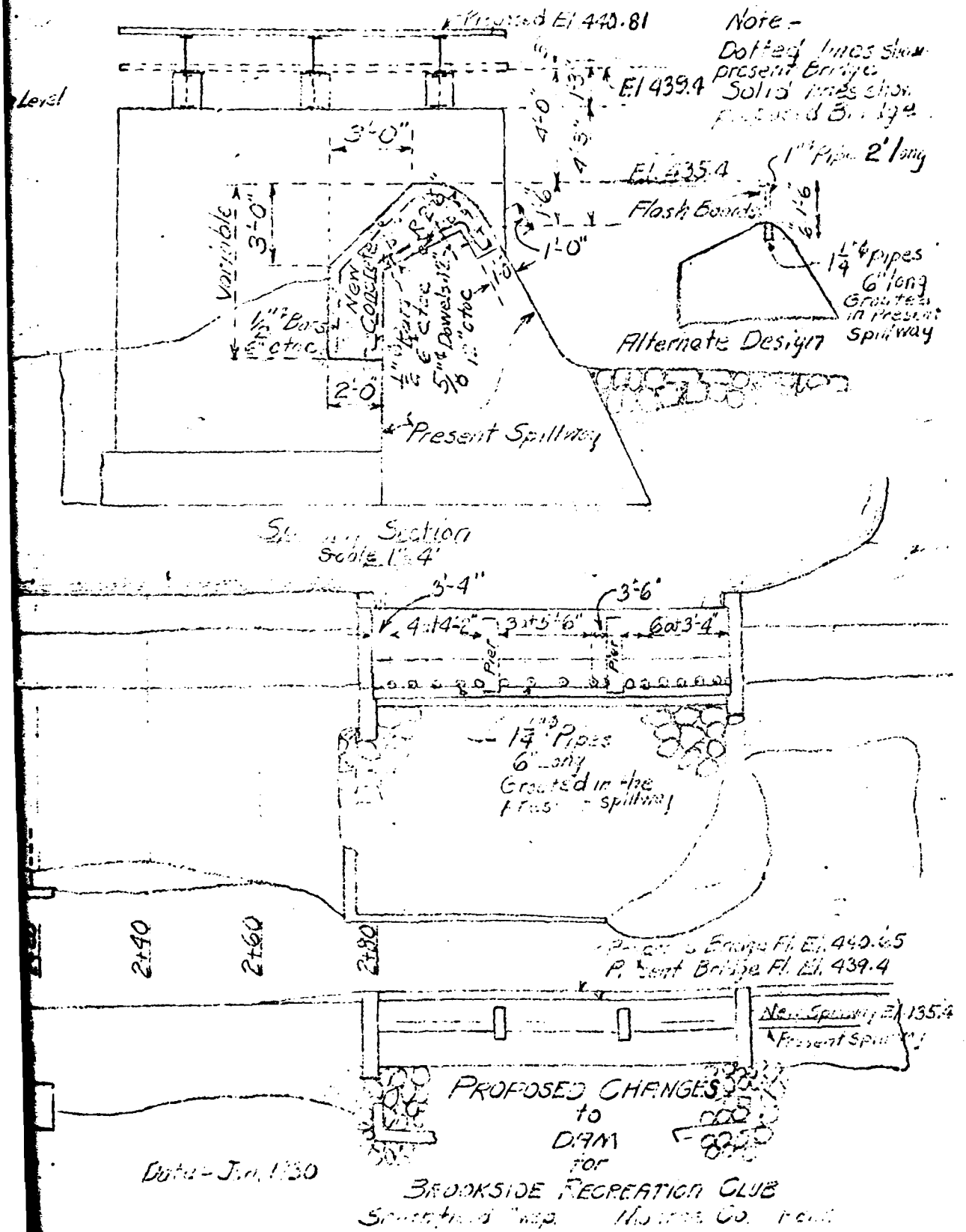




SECTION AT 1+00
SCALE 1"=6'

PROPOSED DAM
ACROSS
SHAWNEE CREEK
FOR
BROOKSIDE RECREATION CLUB
SMITHFIELD TOWNSHIP
MONROE CO. PENN.
JULY 1926


El. 439.4
El. 437.7
El. 435.4 Fence
Slope 1 on 2
New Earth
Sta. 1+40.
El. 437.7
Slope 1 on 2
New Earth
Sta. 2+40
Scale 1"=10'
Average Elevation 439.4
Toe of Present Slope
Toe of New Slope
GENERAL PLAN
0+20
0+40
0+60
0+80
1+00
1+20
1+40
1+60
1+80
2+00
El. 431.4
LONGITUDINAL SECTION
Scale 1"=20'



PHASE I INSPE
NATIONAL DAM INS
SHAWNE
SHAWNEE DEVE
1930 MODIF
JANUARY 1980

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DAM
OPMENT INC.
CATIONS
PLATE E-3

3

APPENDIX F

GEOLOGY

SHAWNEE DAM

APPENDIX F

GEOLOGY

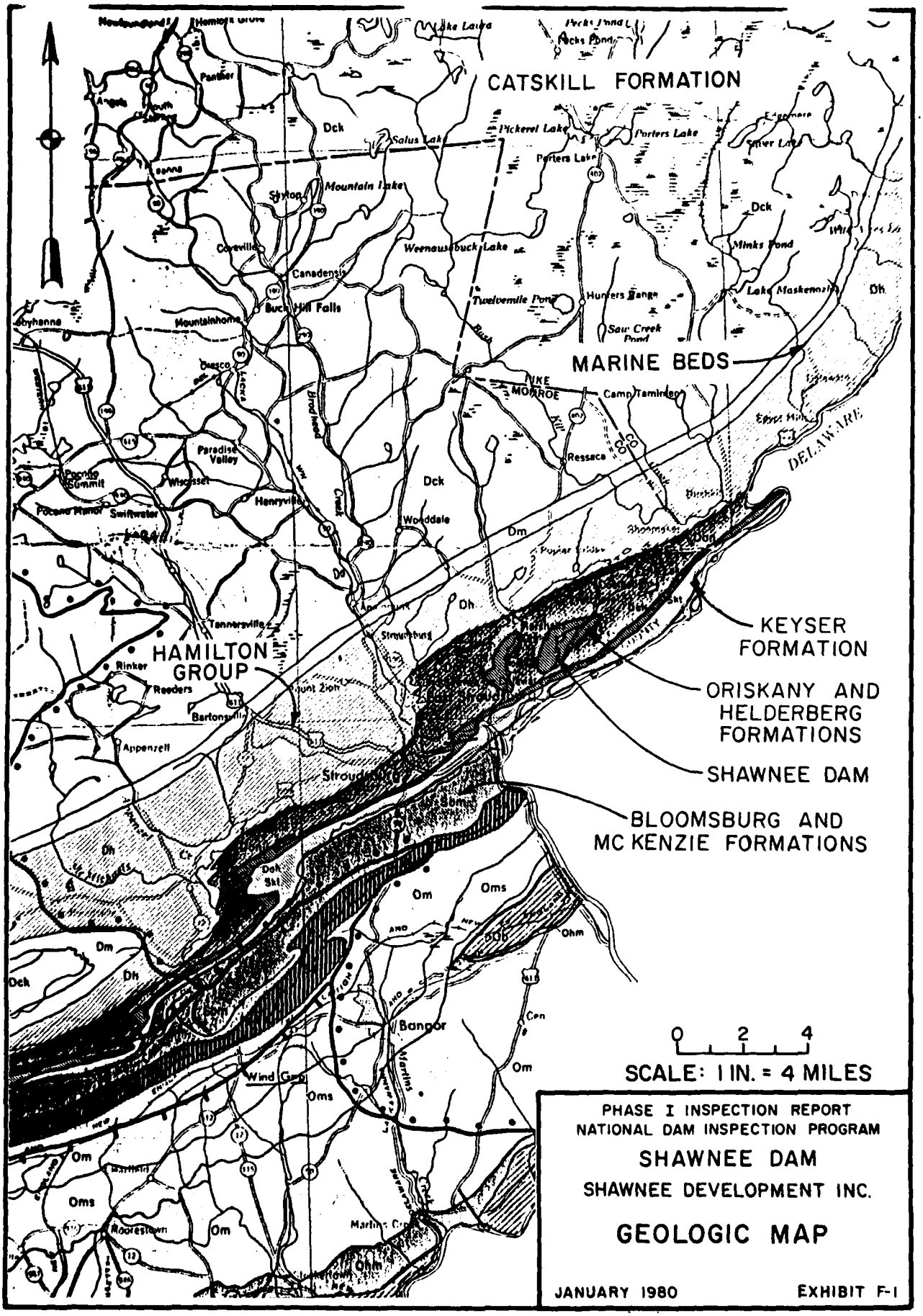
Shawnee Dam is located in Monroe County in the Ridge and Valley Physiographic Province. The Ridge and Valley Province extends along the Delaware River in the extreme southwestern portion of the County. It comprises only 4 percent of the County's area. The remainder of the county is in the Appalachian Plateau Province.

The Ridge and Valley Province is characterized by a series of parallel folds, which are the result of several orogenic events in eastern North America. At the Delaware River, the mountains terminate abruptly, forming the well known water gaps of northeastern Pennsylvania.

Shawnee Dam is underlain by the Oriskany Formation. The Oriskany Formation is a fine- to coarse-grained sandstone. Bedding is well-developed and thick. Porosity of this formation is highly variable, depending on the amount of calcareous or siliceous cement. In areas where calcareous cement is predominant, primary porosity is high. Where silica is the predominant cement, moderate to high effective porosity results from joints and fractures.

The more resistant, siliceous-cemented sections maintain stable slopes in steep cuts. However, where calcareous cement is present, the rock weathers rapidly and has poor stability even on gentle slopes. Resistant, well-cemented rocks of the Oriskany formation are reported to provide good foundations for heavy structures.

From available construction records the dam is reported to be founded on silty clay overburden. Typically, the clays are poorly drained, loamy, glacial and floodplain deposits derived from shale, siltstone and fine-grained sandstone. The available records indicate that some fine gravel is present beneath the dam in the original stream channel and under the right abutment.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SHAWNEE DAM

SHAWNEE DEVELOPMENT INC.

GEOLOGIC MAP

JANUARY 1980 EXHIBIT F-1